Evaluation and Implementation of Shared Spaces in NSW

Macroscopic speed and safety evaluation of the impacts of shared spaces in NSW

Final Report

November 2025

Transport Research Centre (TRC), School of Civil and Environmental Engineering,
University of Technology Sydney (UTS)
Supported by SCT Consulting

This research is funded by Transport for New South Wales and the iMOVE CRC and supported by the Cooperative Research Centres program, an Australian initiative.

Contributors

Dr Kasun Wijayaratna
Dr Cecilia da Rocha
Dr Amir Mortazavi
Dr Niousha Bagheri
Benjamin Hartmann
Abigail O'Mahoney
Anthony Lau
Mitchell Elbourne

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Transport for NSW and is subject to and issued in accordance with the agreement between Transport for NSW and the University of Technology Sydney. Care has been taken in the preparation of this report based on available evidence. The University of Technology Sydney does not make any representations or state that the report is free from error, is current, or, where used, will ensure compliance with any legislative, regulatory, or general law requirements. The University of Technology Sydney does not accept any liability or responsibility, including for any loss or damage, resulting from reliance on this document. Copying this report without the permission of Transport for NSW and the University of Technology Sydney is not permitted.

Generative Artificial Intelligence tools were used to assist in the editing and refinement of written content, however, all research design, data analysis, interpretations, and conclusions were developed solely by the research team at the University of Technology Sydney.

Document Control			
Version	**Date**	**Author/s**	**Reviewer/s**
Draft_V1	13/10/2025	Kasun Wijayaratna Cecilia da Rocha Amir Mortazavi Niousha Bagheri Benjamin Hartmann Abigail O'Mahoney Mitchell Elbourne Anthony Lau	Cecilia da Rocha Kasun Wijayaratna
Final	25/11/2025	Kasun Wijayaratna Cecilia da Rocha Amir Mortazavi	Cecilia da Rocha Kasun Wijayaratna
Publication	26/07/2026	Kasun Wijayaratna	Chris Pope

Table of Contents

List of Figures 4
List of Tables 6
Executive Summary 10
1 Introduction 13
1.1 UTS Shared Spaces Research Program 14
1.2 Outcomes to Date 16
1.3 Project Objectives 16
1.4 Report Structure 16
2 Empirical Data Collection 18
2.1 Identification of Data Requirements 18
2.2 Case Study Site Selection 20
2.3 Objective Data 22
2.3.1 Collated Data 22
2.3.2 Collected Data 23
2.4 Subjective Data: Survey Development 23
2.4.1 Intercept Survey Development 25
2.4.2 Online Survey Development 27
2.5 Subjective Data: Survey Implementation 28
2.5.1 Intercept Survey Implementation 28
2.5.2 Online Survey Implementation 29
3 Macroscopic Collation and Analysis 31
3.1 Development of Data Platform 31
3.2 Crash Data Analysis 32
3.2.1 Shared Spaces and Vulnerable Road Users 34
3.3 Posted Speed Limit Analysis 36
3.3.1 Correlation between Crashes and Posted Speed Limits 37
3.4 Speed Compliance Analysis 38
3.5 Crash Risk Assessment 39
3.5.1 General Crash Risk 40
3.5.2 Pedestrian Crash Risk 41
3.5.3 Cyclist Risk 42
3.5.4 Correlation Analysis of Active Transport Modes 43
3.6 Summary of Outcomes 44
4 Case Study Evaluation 45
4.1 Performance Summary of Case Study Sites 45
4.1.1 Destination High Streets 46

4.1.2 Residential Lanes/Ways, Neighbourhood Streets, Yield Streets 58
4.1.3 Connector Streets 67
4.1.4 Intersections within Shared Environments 79
4.1.5 Summary of Findings 90
4.2 Subjective Data Analysis 98
4.2.1 Intercept Survey 98
4.2.2 Online Survey 107
4.2.3 Appropriate Speed Limit Response Assessment 113
4.3 Statistical Modelling for Perceived Safety Assessment 117
4.3.1 Community Safety Perceptions from Intercept Survey 118
4.3.2 Mode-specific Safety Perceptions from Online Survey 123
4.3.3 Elasticity Analysis 131
4.3.4 Summary of Modelling Outcomes 134
5 Practitioner Guidance for enhanced Shared Space Development 136
5.1 Implications for the NSW Speed Zoning Standard (TS 03631:2.0) 136
5.1.1 Reinforcing Safe Systems Principles 136
5.1.2 Aligning Speed with Place Context 137
5.1.3 Self-Explaining and Compliance-Supporting Design 137
5.1.4 Engaging Communities and Local Government 138
5.1.5 Recommendations for Improving the NSW Speed Zoning Standard 138
5.2 Implications for NSW Design of Roads and Streets (DORAS) Manual 139
5.2.1 Incorporation of Safety in the Identification of Issues, Opportunities and Options 140
5.2.2 Integration of Community Insights into Issue Identification 141
5.2.3 Use of Case Study References 142
5.2.4 Recommendations for Improving the NSW Design of Roads and Streets (DORAS) 142
5.3 Translating Research into Practice 143
5.3.1 Safety Mapping 143
5.3.2 Crash Risk Assessment 144
5.3.3 Case Study Evaluation – Community Survey Tools 145
5.3.4 OLR Model Application 146
6 Concluding Remarks 148
6.1 Limitations and Future Work 149
6.2 Contribution and Impact 151
7 References 152

List of Figures

Figure 1: Before and After - Fort Street, Auckland, New Zealand 13

Figure 2: The number of pedestrians and cyclists killed or injured between 2005 and 2023 (*Source: (Centre for Road Safety: Transport for NSW, 2024)*) 14
Figure 3: Research program structure (stages already completed marked in green) 15
Figure 4: Report Structure and Logic. 17
Figure 5: Locations of case study sites 22
Figure 6: Intercept survey deployment at Portman Street/Merton Street Green Square (weekend) 29
Figure 7: Identification of post-codes in Greater Sydney (used for region based stratification) 30
Figure 8: Database development methodology 31
Figure 9: Heat map of Greater Sydney LGAs based on total number of crashes and near misses. 32
Figure 10: Top 10 LGA rankings for total crashes and near misses 33
Figure 11: Annual variation in fatalities and serious injury across the ten LGAs with the highest crashes. 34
Figure 12: Mapping of shared space and zone infrastructure and corresponding crash location data within the City of Sydney. 35
Figure 13: Shared zone at Dixon Street, Sydney 35
Figure 14: Spatial heat maps of pedestrian crash risk for 2022 and 2023 by LGAs in Greater Sydney 41
Figure 15: Spatial heat maps of cycling crash risk for 2022 and 2023 by LGAs in Greater Sydney 42
Figure 16: Site photographs of Albert Street, Freshwater 46
Figure 17: Site map of Albert Street, Freshwater extension to Lawrence Street. 46
Figure 18: Safety map of Albert Street, Freshwater (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 48
Figure 19: Site photographs of Main Street, Blacktown 50
Figure 20: Site map of Main Street, Blacktown 50
Figure 21: Safety map of Main Street, Blacktown (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 52
Figure 22: Site photographs of Bankstown City Plaza, Blacktown 54
Figure 23: Site Map of Bankstown City Plaza, Bankstown 54
Figure 24: Safety map of Bankstown City Plaza, Bankstown (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 56
Figure 25: Site photographs of Chisholm Street, Darlinghurst 58
Figure 26: Site Map of Chisholm Street, Sims Street, Hannam Street and Flemings Lane 58
Figure 27: Safety map of Chisholm Street, Darlinghurst (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 60
Figure 28: Site photographs of Meehan Street, Granville 62
Figure 29 Site Map Meehan Street, Granville 62
Figure 30: Safety map of Meehan Street, Granville (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 64
Figure 31: Site photographs of N Steyne and S Steyne, Manly 67
Figure 32: Site Map of South Steyne and North Steyne 67
Figure 33: Safety map of N Steyne and S Steyne, Manly (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 69
Figure 34: Site photographs of Peats Ferry Road, Hornsby 71
Figure 35: Site Map of Peats Ferry Road 71
Figure 36: Safety map of Peats Ferry Road, Hornsby (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 73
Figure 37: Site photographs of Henderson Road, Edmondson Park 75
Figure 38: Site Map of Henderson Road 75
Figure 39: Safety map of Henderson Road, Edmondson Park (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 77
Figure 40: Site photographs of West Esplanade / East Esplanade / Belgrave Street, Manly 79
Figure 41: Site map of West Esplanade / East Esplanade / Belgrave Street, Manly 79

Figure 42: Safety map for West Esplanade / East Esplanade / Belgrave Street, Manly (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 81
Figure 43: Site photographs of Anderson Street / Victoria Avenue, Chatswood 83
Figure 44 Site map of Anderson Street / Victoria Avenue 83
Figure 45: Safety map for Anderson Street / Victoria Avenue, Chatswood (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 85
Figure 46: Site photographs of Portman Street / Merton Street, Green Square 87
Figure 47 Site map of Portman Street / Merton Street, Green Square 87
Figure 48: Safety map for Portman Street / Merton Street, Green Square (recorded crashes from 2019 to 2023 and near misses 2022 to 2023). 89
Figure 49: Aggregated response proportions ("Easy" and "Very easy") for functionality questions comparing the online survey with the field intercept survey 108
Figure 50: Illustration of probability curves from an OLR, highlighting how changes to an independent variable impact the perception of safety 118
Figure 51: Reproduction of "*Figure 5b - Flow chart on the planning and design process and where to find resources during each step*" from DORAS (2023) 140
Figure 52: Potential application of the safety mapping tool 144
Figure 53: Potential application of the crash risk assessment methodology 145
Figure 54: Potential application of the community survey tools 146
Figure 55: Potential application of the OLR model estimates 147
Figure 56: Zone based approach to shared space design(Elliot et al., 2017) 149
Figure 57: UTS Shared Spaces Research Program future stages 150

List of Tables

Table 1: Summary of data requirements, sources and level of aggregation (blue shaded rows were data sets used for the macroscopic analysis) 19
Table 2: Case study sites 21
Table 3: Finalised structure of questionnaire surveys (Intercept survey and online survey) 24
Table 4: Completed and valid questionnaires per street for intercept and online surveys 28
Table 5: Intercept survey implementation 29
Table 6: Sample stratification for online survey 30
Table 7: Severity profile across the ten LGAs with the highest number of crashes 2019 to 2023 34
Table 8: Distribution of crash statistics based on posted speed limit accounting for crash severity 37
Table 9: Correlation between posted speed limit and crash statistics (2019 – 2023) 37
Table 10: Speed compliance percentages by posted speed limit (Greater Sydney) 38
Table 11: Comparison of aggregated crashes and crash risk by LGA for the Greater Sydney. 40
Table 12: Ten leading LGAs according to pedestrian crash risk for 2022 and 2023 41
Table 13: Ten leading LGAs according to cycling crash risk for 2022 and 2023 43
Table 14: Correlations between walking and cycling trips and categorised crash data 43
Table 15: Correlations between the length of low-speed environment road network and crash risk 44
Table 16: Translation of "Likert Questions" presented in site summaries 45
Table 17: Summary table of pneumatic tube data at Albert Street, Freshwater (bi-direction statistics) 47
Table 18: Summary table of pedestrian behaviour at Albert Street, Freshwater (bi-direction statistics) 48
Table 19: Summary of intercept survey results for Albert Street, Freshwater 49
Table 20: Summary of online survey results for the imagery of Albert Street, Freshwater 49
Table 21: Summary table of pneumatic tube data at Main Street, Blacktown (bi-direction statistics) 51
Table 22: Summary table of pedestrian behaviour at Main Street, Blacktown (bi-direction statistics) 51

Table 23: Summary of intercept survey results for Main Street, Blacktown 52
Table 24: Summary of online survey results for the imagery of Main Street, Blacktown 53
Table 25: Summary table of pneumatic tube data at Bankstown City Plaza, Bankstown (bi-direction statistics) 55
Table 26: Summary table of pedestrian behaviour at Bankstown City Plaza, Bankstown (bi-direction statistics) 55
Table 27: Summary of intercept survey results for Bankstown City Plaza, Bankstown 56
Table 28: Summary of online survey results for the imagery of Bankstown City Plaza, Bankstown 57
Table 29: Summary table of pneumatic tube data at Chisholm Street (bi-direction statistics) 59
Table 30: Summary table of pedestrian behaviour at Darlinghurst shared space streets (bi-direction statistics) 59
Table 31: Summary of intercept survey results for Chisholm Street, Darlinghurst 60
Table 32: Summary of online survey results for the imagery of Chisholm Street, Darlinghurst 61
Table 33: Summary table of pneumatic tube data at Meehan Street, Granville (bi-direction statistics) 63
Table 34: Summary table of pedestrian behaviour at Meehan Street, Granville (bi-direction statistics) 63
Table 35: Summary of intercept survey results for Meehan Street, Granville 64
Table 36: Summary of online survey results for the imagery of Meehan Street, Granville 65
Table 37: Summary table of pneumatic tube data at N Steyne and S Steyne, Manly (bi-direction statistics) 68
Table 38: Summary table of pedestrian behaviour at N Steyne and S Steyne, Manly (bi-direction statistics) 68
Table 39: Summary of intercept survey results for N Steyne and S Steyne, Manly 69
Table 40: Summary of online survey results for the imagery of N Steyne and S Steyne, Manly 70
Table 41: Summary table of pneumatic tube data at Peats Ferry Road, Hornsby (bi-direction statistics) 72
Table 42: Summary table of pedestrian behaviour at Peats Ferry Road, Hornsby (bi-direction statistics) 72
Table 43: Summary of intercept survey results for Peats Ferry Road, Hornsby 73
Table 44: Summary of online survey results for the imagery of Peats Ferry Road, Hornsby 74
Table 45: Summary table of pneumatic tube data at Henderson Road, Edmondson Park (bi-direction statistics) 76
Table 46: Summary table of pedestrian behaviour at Henderson Road, Edmondson Park (bi-direction statistics) 76
Table 47: Summary of intercept survey results for Henderson Road, Edmondson Park 77
Table 48: Summary of online survey results for the imagery of Henderson Road, Edmondson Park 78
Table 49: Summary table of pneumatic tube data on the approaches to the intersection of West Esplanade / East Esplanade / Belgrave Street, Manly (bi-direction statistics) 80
Table 50: Summary table of pedestrian behaviour on the approaches to the intersection of West Esplanade / East Esplanade / Belgrave Street, Manly (bi-direction statistics) 80
Table 51: Summary of intercept survey results for West Esplanade / East Esplanade / Belgrave Street, Manly 81
Table 52: Summary of online survey results for the imagery of West Esplanade / East Esplanade / Belgrave Street, Manly 82
Table 53: Summary table of pneumatic tube data on the approaches to the intersection of Anderson Street / Victoria Avenue, Chatswood (bi-direction statistics) 84
Table 54: Summary table of pedestrian behaviour on the approaches to the intersection of Anderson Street / Victoria Avenue, Chatswood (bi-direction statistics) 84
Table 55: Summary of intercept survey results for Anderson Street / Victoria Avenue, Chatswood 85
Table 56: Summary of online survey results for the imagery of Anderson Street / Victoria Avenue, Chatswood 86

Table 57: Summary table of pneumatic tube data on the approaches to the intersection of Portman Street / Merton Street, Green Square (bi-direction statistics) 88
Table 58: Summary table of pedestrian behaviour on the approaches to the intersection of Portman Street / Merton Street, Green Square (bi-direction statistics) 88
Table 59: Summary of intercept survey results for Portman Street / Merton Street, Green Square 89
Table 60: Summary of online survey results for the imagery of Portman Street / Merton Street, Green Square 90
Table 61: Summary of vehicle and bicycle movement characteristics across all twelve case study sites, grouped by DORAS typology 94
Table 62: Summary of pedestrian behaviour across all twelve case study sites, grouped by DORAS typology 95
Table 63: Summary of face-to-face survey results across all twelve case study sites (combined results for rating 4 (*Safe*) and 5 (*Very Safe*)) 96
Table 64: Summary of words most commonly associated with each street across all twelve case study sites based on online survey responses. 96
Table 65: Summary of improvement priorities and key safety concerns identified through the online survey across all twelve case study sites. 97
Table 66: Field intercept data sample details 98
Table 67: Aggregated response proportions for the question, "How easy or difficult is it to perform the following activities on the street?" 99
Table 68: Aggregated response proportions for the question, "How would you rate the following aspects for the street?" 99
Table 69: Suitability and safety response proportions across each 12 case study sites 100
Table 70: NVivo analysis of text comments gathered from the intercept survey 102
Table 71: Persona Categories 103
Table 72: Proportion of responses that selected “easy to perform” or “very easy to perform” across functionalities 104
Table 73: Proportion of responses that selected "suitable" or "very suitable" across street aspects/features 104
Table 74: Response proportions for the question "Overall, the street we are standing on is..." 105
Table 75: Response proportions for the question: "In your opinion, what would be an appropriate speed limit for motor vehicles on the street we are in?" 105
Table 76: Variable combinations considered in correlation analysis of the intercept survey data 106
Table 77: Highest observed correlations within the intercept survey data 107
Table 78: Online survey data sample details 107
Table 79: Gender distribution 108
Table 80: Age distribution 108
Table 81: Employment status distribution 108
Table 82: Income distribution 108
Table 83: Users’ safety perceptions (“Safe” or “Very Safe”) by mode interaction. 109
Table 84: Non-users’ safety perceptions (“Safe” or “Very Safe”) by mode interaction. 110
Table 85: Aggregated response proportions for the question, "Select the 5 key aspects that most often need improvements in streets like the one shown above” 111
Table 86: Aggregated response proportions for the question, "Select the 5 key safety concerns for streets like the one shown above” 111
Table 87: Variable combinations considered in correlation analysis of the online survey data 112
Table 88: Highest observed correlations within the online survey data 113
Table 89: Distribution of responses for the “appropriate speed” question within the intercept survey. 114
Table 90: Distribution of responses for the “appropriate speed” question within the online survey. .. 115
Table 91: Comparison of observed speed metrics and the responses to the "appropriate speed" question in the intercept and online surveys across the twelve case study sites. 115
Table 92: Ordinal scale reference table for dependent variable responses 119

Table 93: Ordinal scale referencing for independent variable responses 119
Table 94: Non-normalised OLR model estimation results 120
Table 95: Normalised OLR model estimation results. 122
Table 96: Goodness of fit results for the estimated OLR models 122
Table 97: Correlations between a variable being identified "improvement identification" variables and "improvement prioritisation" variables 124
Table 98: Cyclist interaction OLR model estimation results 125
Table 99: Motorcyclist interaction OLR model estimation results 126
Table 100: Car interaction OLR model estimation results 127
Table 101: Heavy Vehicle interaction OLR model estimation results 129
Table 102: Goodness of fit metrics across all mode-specific interaction models. 130
Table 103: Example of elasticity considering Average Speed (Community Safety Perception Model) 131
Table 104: Elasticity results of key variables across the Community Safety Perception model. 132
Table 105: Elasticity results of key variables across the Cyclist Interaction model. 132
Table 106: Elasticity results of key variables across the Motorcyclist Interaction model. 133
Table 107: Elasticity results of key variables across the Car Interaction model. 133
Table 108: Elasticity results of key variables across the Heavy Vehicle Interaction model. 134
Table 109: Recommendations for improving the NSW Speed Zoning Standard 139
Table 110: Recommendations for improving DORAS 143
Table 111: Predicted probabilities of safety before and after the inclusion of a separated cycleway 146

Executive Summary

Shared spaces are street environments designed to minimise physical separation between users, reducing vehicle dominance, encouraging lower operating speeds, and improving the overall quality of place. In New South Wales, they are most commonly associated with designated Shared Zones (10 km/h), where drivers are required to give way to all pedestrians. However, guidance remains limited for other shared-space typologies that aim to balance movement and place functions, particularly in quieter suburban and urban streets.

This project represents a major step forward in developing an **empirical evidence base for shared and low-speed environments** in New South Wales. It forms **Stage 2b** of the **UTS Shared Spaces Research Program**, led by the **Transport Research Centre (TRC)** within the **School of Civil and Environmental Engineering at the University of Technology Sydney (UTS)**, commissioned by **Transport for NSW (TfNSW)** and supported by the **iMOVE CRC**. This overall aim of the Research Program is to **establish the definition and understanding of shared space designs to provide transport practitioners additional options and guidance to define successful places.** The work presented in this report refers to and reflects upon Stage 1, a comprehensive literature review and Stage 2a, a collection of shared road infrastructure perspectives.

The research adopted a **multi-scale methodology**, combining both strategic and operational analyses to understand the performance and safety of shared spaces:

- **Macroscopic analysis:** Development of an integrated NSW-wide database combining **crash, speed, and near-miss data** to assess spatial crash risk and exposure relationships.
- **Case study analysis:** Detailed investigation of **12 shared-space sites** selected based on the Design of Roads and Streets (DORAS) manual, across Greater Sydney, capturing **objective data** (vehicle speeds, traffic volumes, pedestrian counts) and **subjective data** (community perceptions, safety and functionality ratings).
- **Analytical modelling:** Application of **Ordered Logistic Regression (OLR)** models to quantify the relationships between street design, safety perceptions, and functionality, linking technical performance with human experience.

Together, these methods provided both state-wide insights and location-specific understanding of how shared spaces operate in practice.

Key Findings

- **Infrastructure and crash risk**: Local Government Areas (LGAs) with less pedestrian and cycling infrastructure exhibit higher exposure-normalised crash risk, reinforcing the value of active transport investment.
- **Speed zoning and crash severity:** Strong positive correlations are observed between posted speed limits and crash severity within the 10–70 km/h range, where a majority of urban crashes occur. Correlation coefficients were above 0.68 for crashes, fatalities, and serious injuries indicate that increases in posted limits within moderate-speed environments substantially elevate both crash frequency and severity.
- **Speed compliance of low speed environments**: Considering aggregated link level data as well as case study specific data, speed compliance of environments with 30km/h to 50km/h posted speed limits is reasonable (85% - 97% compliance). However, while 85th percentile speeds in 10km/hr-20 km/h zones remain within safe systems limits (i.e. less than 30km/h), compliance rates are considerably lower (only 60%-70%). This suggests that very low-speed environments require stronger design cues (such as textured pavements, narrow carriageways, and landscaping) to reinforce driver expectations.

- **Community acceptance**: Community sentiment strongly favoured low-speed environments across the investigated shared space case study sites, where most respondents preferring that posted limits remain at or below existing levels.
- **Design and behavioural insights**: Streets with clear pedestrian features (such as crossing infrastructure, signage, etc.), high environmental quality (including landscaping and cleanliness, etc.), and adequate street furniture (seating, lighting, etc.) were consistently associated with higher safety perceptions. Conversely, car-dominant layouts and poor cycling infrastructure reduced perceived safety and comfort.
- **Objective performance**: Traffic and pedestrian volumes were consistent across sites, with variations by street type and time of week. Shared zones with 10 km/h limits were the only areas showing significant non-compliance, suggesting design refinements are needed.
- **Safety outcomes**: Most case study sites exhibited low crash frequencies compared to surrounding streets, indicating that well-designed shared and low-speed environments can achieve both safety and accessibility outcomes.
- **Perception priorities**: Both intercept and online surveys identified street furniture, cycling infrastructure, and pedestrian safety in relation to motor vehicles as the top priorities for improvement.

Key Contributions

- **Integrated macroscopic database**: A novel NSW-wide compilation of crash, speed, and near-miss data derived from publicly available sources and commercially procured datasets (including Compass IoT). This resource enables practitioners to visualise and interpret safety performance across diverse environments and complements existing internal risk-analysis tools used within TfNSW.
- **Exposure-based crash-risk modelling**: The first Australian application combining active-transport exposure estimates with crash data at LGA level to guide funding and prioritisation.
- **Empirical data collection**: The first coordinated campaign in Australia examining shared-space infrastructure through speed, pedestrian, and survey data, expanding upon international studies (CIHT, 2018).
- **Novel analytical tools**: The use of Ordered Logistic Regression and structured perception surveys to quantify hard-to-measure aspects—such as comfort, perceived safety, and street functionality—in the context of real design features.
- **Policy relevance**: Findings directly inform updates to DORAS and the NSW Speed Zoning Standard, embedding perception-based evidence into guidance and decision-making.

Limitations and Future Work

While significant progress was made, several areas warrant further investigation:

- **Crash data limitations:** Crash records are valuable for post-event analysis but not proactive risk prevention. Future work should include **high-risk or black spot locations** and leverage **near-miss data** for predictive safety evaluation.
- **User group diversity:** Future surveys should include **drivers, cyclists, and motorcyclists** to expand behavioural insights.
- **Advanced modelling:** Future program stages will employ Structural Equation Modelling (**SEM), simulation modelling**, and **before-and-after studies** to validate and operationalise the predictive models developed.

Concluding Remarks

This project establishes a **repeatable, evidence-based framework** for evaluating shared and low-speed environments across NSW. By integrating macroscopic data, on-site measurement, and community perceptions, it provides TfNSW and local governments with a robust foundation for:

- Prioritising investment and funding allocation.
- Refining DORAS guidance and the NSW Speed Zoning standard.
- Designing safer, more inclusive, and more liveable streets.

The continued development of the ***UTS Shared Spaces Program***, including simulation-based and longitudinal evaluations, will further bridge the gap between perception, design, and performance. This will continue to position NSW as a national leader in **human-centred, data-informed street design.**

1 Introduction

Road networks have long served dual functions, supporting both movement and place. During the 1950s and 60s, many developed cities with urban environments became increasingly vehicle-centred, prioritising efficient motorised travel over their social and civic roles. However, as contemporary cities densify and available land for community use becomes more constrained, there is renewed focus on re-establishing streets as places for people. Environments are increasingly including spaces that support social interaction and encourage active mobility such as walking and cycling. ***Shared spaces*** aim to equalise priority across travel modes to reduce the dominance of private vehicles, thus encouraging active modes of transport and reclaiming roads and streets as spaces for people and the community to walk and gather. Figure 1 presents an example of a shared space transformation in Auckland, New Zealand where the introduction of vegetation, seating and alternative pavement design has been effective in establishing a place tailored to the local context. This example has led to several enhancements in performance metrics such as reduced vehicular traffic and speeds and importantly an increase in value perceived by the community.

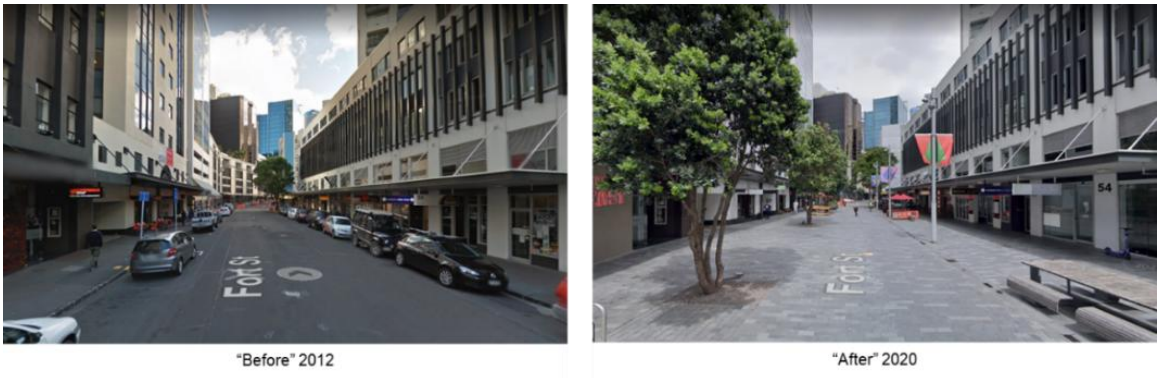


Figure 1: Before and After - Fort Street, Auckland, New Zealand

However, the way specific design parameters of roads and streets (such as lane width, number of lanes, parking options, speed limits, tree coverage, urban furniture, etc.) enable safe and successful integration of both movement and place remains unclear. In particular, the link between such parameters and performance metrics (number of accidents, diversity of people using the streets, etc) is not yet established.

In New South Wales (NSW), road trauma continues to present a significant challenge (Law et al., 2024). The "*Road Traffic Casualty Crashes in New South Wales – Statistical Statement for the year ended 31 December 2023*" presents a safety summary for the state. Positively, there has been a gradual downward trend in road fatalities and injuries. As stated in the statement, "*The number of persons killed per 100,000 population was 4.1. This is the fourth-lowest fatality rate since records were first compiled in 1908*" (Centre for Road Safety: Transport for NSW, 2024). When comparing data over the last five years, there have been increases in both injuries and fatalities, which can be attributed to lower travel levels during 2020 and 2021 because of the COVID-19 pandemic. As presented in Figure 2, focussing on crashes involving pedestrians and cyclists, the number of killed and injured has increased to values that are similar to pre-pandemic conditions, suggesting that safety outcomes have not improved significantly over the last five years. The most recent preliminary data which considers crashes until September 2025 (Centre for Road Safety: Transport for NSW, 2025) highlight that there have been 39 more fatalities for the calendar year to date for 2025 as compared with 2024, 13 of which have been pedestrians and cyclists. In total there have been 270 fatalities, which is nearly 17% greater than for the same time in 2024. This represents the highest total for the January–September period since 2018 (273 fatalities), underscoring the urgent need to reduce road trauma and advance the goals of Vision Zero.

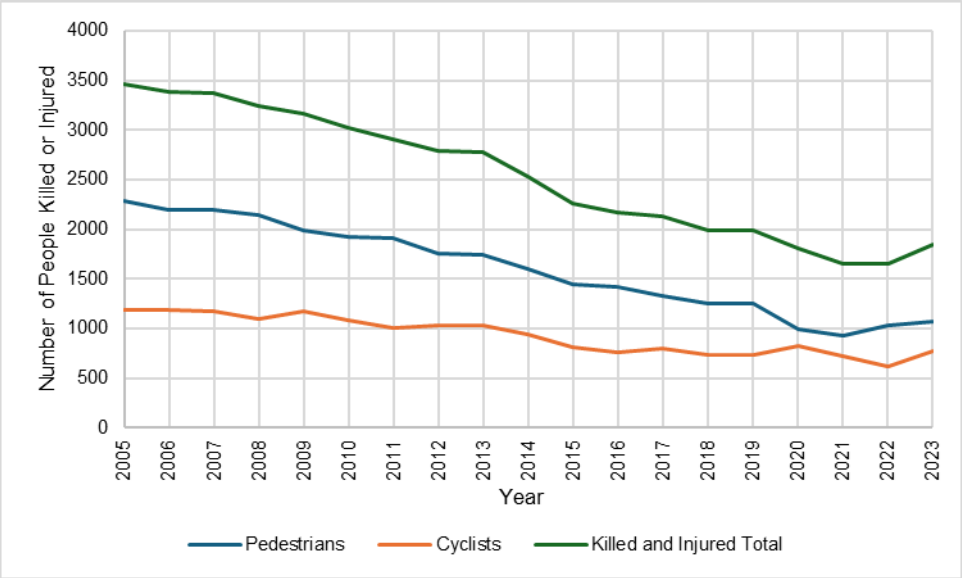


Figure 2: The number of pedestrians and cyclists killed or injured between 2005 and 2023 (*Source: (Centre for Road Safety: Transport for NSW, 2024)*)

Thus, future road environments must allow for efficient movement, encourage the formation of places for people and most importantly aim to improve safety for all users. Shared spaces are a potential solution that offers a balance between movement and place; however, strategic design and implementation is necessary to not compromise safety. This complex set of objectives provided the motivation for this research. The Transport Research Centre (of the School of Civil and Environmental Engineering, Faculty of Engineering and IT) at UTS was commissioned by TfNSW to investigate further opportunities to enhance place in the context of road infrastructure while also examining potential safety consequences. To address this need, UTS have developed a staged research program that examine shared spaces and the design principles supporting it.

1.1 UTS Shared Spaces Research Program

The research program, ***"Evaluation and Implementation of Shared Spaces in NSW"*****,** presented in Figure 3 investigates the potential application of shared spaces in NSW and intends to form an evidence base and guidance for practitioners for future implementation. Each stage of the research program consists of specific objectives, and the program fulfils an overarching principal objective:

- **Review of Literature (Stage 1):** Synthesise and examine literature, standards, legislation, and guidelines related to the design and implementation of shared spaces in a local and global context.
- **Measure current performance (Stage 2)**: Conduct empirical analysis of existing shared spaces, shared zones and placemaking road infrastructure in New South Wales to measure the current operational performance and safety of shared initiatives.
- **Contextualise design approach and scenario testing (Stage 3)**: Develop novel microsimulation modelling approaches to effectively design, simulate, and assess operations of future shared space implementations.
- **Measure design effectiveness (Stage 4):** Implement share space intersections in field trials and conduct "before and after" studies to quantify the impact of shared spaces in the context of road performance and safety.
- **Establish Guidance (Accumulation of all Stages – Principal Objective):** Define documents and tools for the design and implementation of shared spaces on New South Wales roads

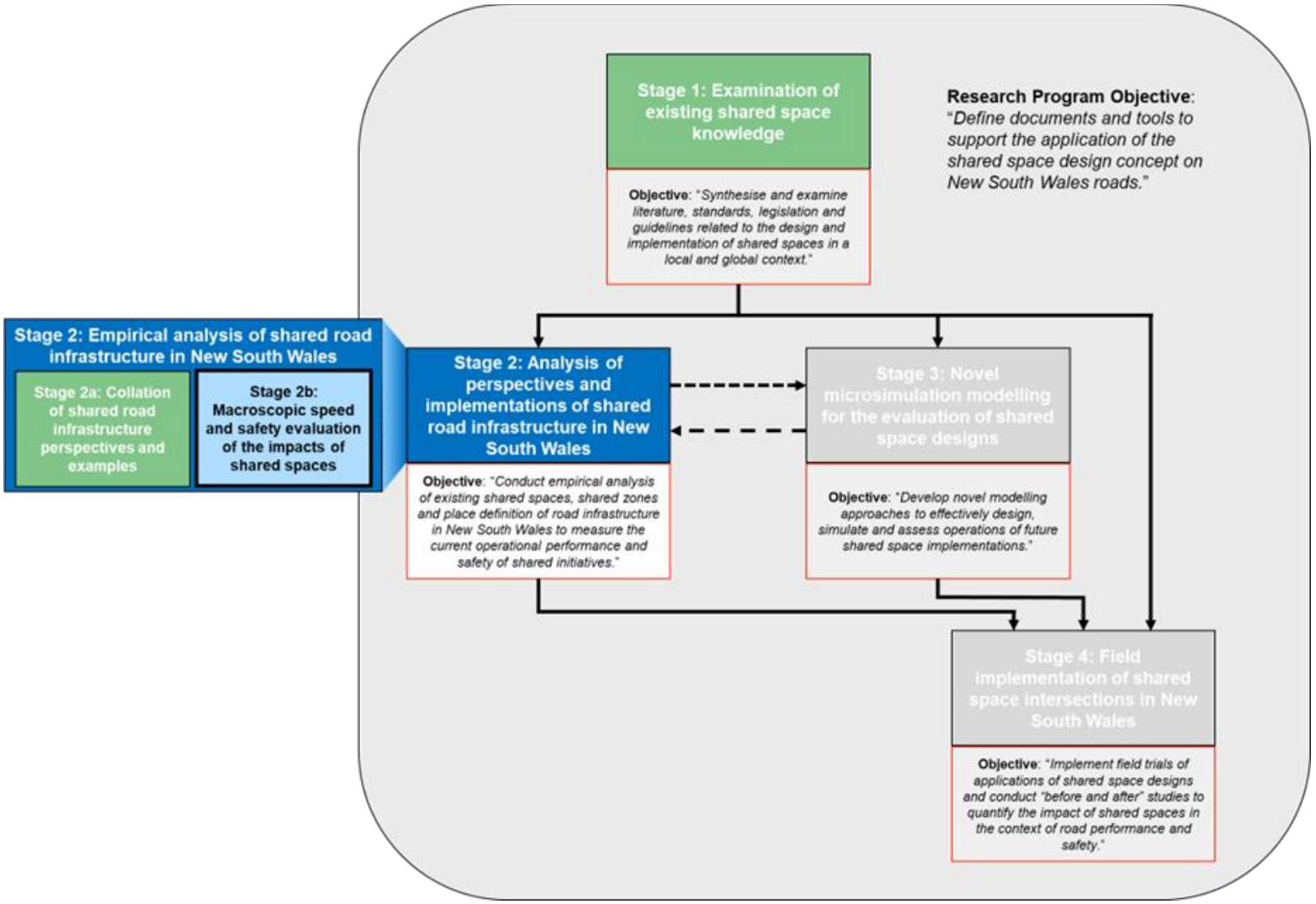


Figure 3: Research program structure (stages already completed marked in green)

1.2 Outcomes to Date

In 2021, UTS completed ***Stage 1: Examination of existing Shared Space knowledge*** for TfNSW which provided a comprehensive review of literature and defined shared spaces in an Australian context. The research examined the origins and evolution of shared space design and reviewed international and local case studies to inform their application in NSW. In collaboration with a TfNSW Working Group, the study identified best practices, opportunities, and constraints, concluding that while shared spaces can enhance place outcomes, their implementation is often limited by current standards and the lack of clear links between design features and performance metrics.

Then, during 2022 and 2023, UTS delivered ***Stage 2a: Collation of shared road infrastructure perspectives and examples*** that provided the evidence base of practitioner perspectives concerning shared space applications and initiated the development of a database of shared space sites. Novel workshops that leveraged the Lego Serious Play technique were designed to gather feedback from practitioners concerning road infrastructure and planning that achieves a balance between movement and place. Collectively, participants suggested "strategic use of shared road infrastructure" indicating zone-based approach are beneficial where separated design attributes are presented alongside shared spaces. Shared space sites were identified and compiled for the City of Sydney, forming a database that not only serves as a valuable resource for future research and practice, but also reveals that most shared space locations are situated in residential areas, underscoring the importance of evaluating their safety performance.

Building upon findings of Stage 2a, the following report details the next step of the research program, Stage 2b: ***"Macroscopic speed and safety evaluation of the impacts of shared spaces in NSW"*** (in short: ***Macroscopic speed and safety evaluation***). This project begins the empirical data collection by conducting a macroscopic speed and safety analysis of the road network in the context of the location of shared spaces. This report addresses the second stage of the program through the collation and collection of empirical data and its subsequent analysis. The report focuses on safety data, but also captures other key variables identified in earlier projects (for example, the number of users across multiple modes, dwell time of pedestrians, speeds and street design features). The analysis focuses on identifying trends within datasets as well as relationships between key variables. **This provides a quantified understanding of the factors that are affected by street designs that aim to safely balance movement and place, serving as guidance for future strategic planning of shared space infrastructure**.

1.3 Project Objectives

The project objectives are to:

- Explore currently available data (crowdsourced and other sources) in combination with field surveys to gather objective and subjective speed and safety data.
- Conduct statistical and spatial analysis to understand opportunities for changes in speed zoning and potential for development (or enhancement) of shared spaces.

1.4 Report Structure

The report is separated into four sections, as depicted in Figure 4. Section 2 describes the empirical data collection detailing the processes of collating and collecting the objective and subjective data. The section provides explanation of the survey development and implementation process. This provided the foundation for the macroscopic analysis (Section 3) and case study evaluation (Section 4). Section 3 presents macro-level trends through the development of an integrated data platform, supported by spatial and statistical analysis and a crash risk assessment across the Sydney metropolitan network. Section 4 focuses on the detailed case study evaluation, combining objective measures and user-reported perceptions to examine patterns in perceived safety and behaviour using descriptive and regression-based modelling techniques. Insights from Section 3 and 4 inform Section 5, which provides

practical guidance for shared space development, including recommendations for future planning and evaluation. Finally, Section 6 concludes the report with a summary of key findings, discussion of broader impacts, and suggested next steps for continuation of the research program.

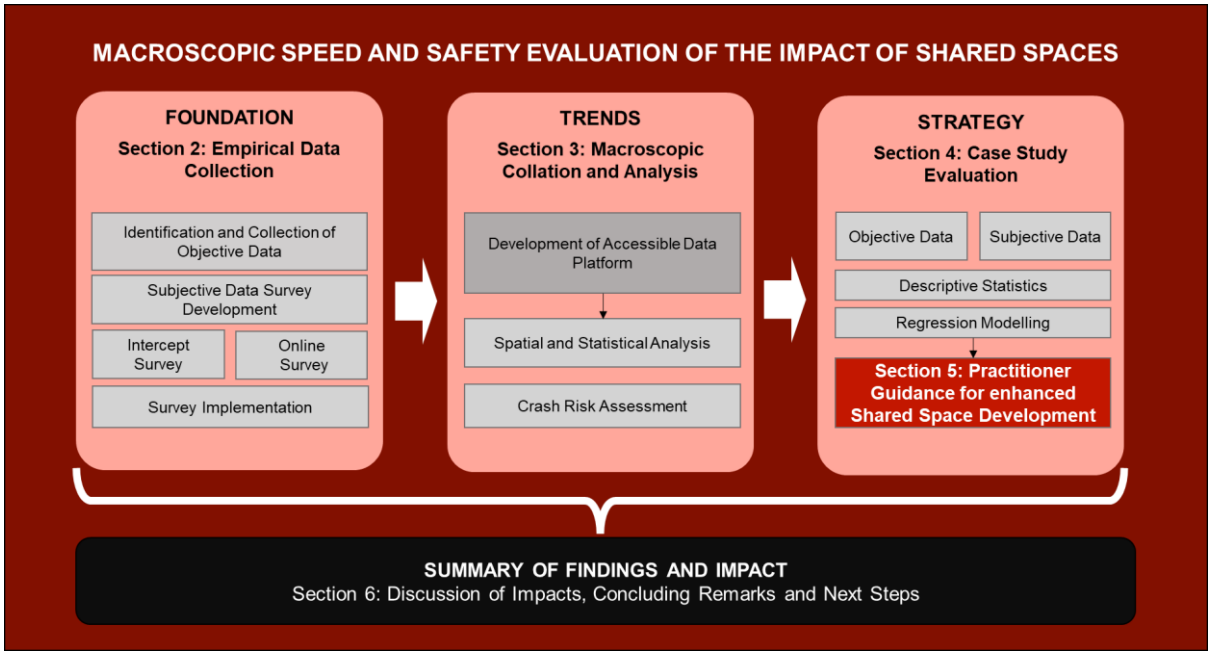


Figure 4: Report Structure and Logic.

2 Empirical Data Collection

Understanding the behaviour of users across streets, with a particular focus on shared environments, requires both measurable performance data (objective data) and insights into the user experiences (subjective data). This section outlines the collation and collection of objective data as well as subjective data gathered through community surveys. While some objective data, such as crash statistics and speed data were available across the Sydney Metropolitan area and in some cases at the state level, other critical indicators like traffic volumes, pedestrian dwell times, and pedestrian counts were limited or unavailable. To address these gaps, more detailed data collection was conducted across 12 case study sites, where objective observations were complemented by face-to-face intercept surveys and on online surveys.

2.1 Identification of Data Requirements

Establishing a robust and relevant set of outcomes required a clear definition of data required to assess the performance of streets and roads at both a macroscopic and site-specific level. This process involved mapping data needs to the project's core objectives, examining how street design, speed and safety influence user perceptions and behaviour. The outcomes of the earlier stages of the research program provided the initial evidence of collecting both objective and subjective data. Furthermore, data requirements were informed by the latest versions of the **NSW Speed Zoning Standard (TS 03631:2.0)** (NSW Government, 2025b) and the **Design of Streets and Roads** (DORAS) (NSW Government, 2023a) which present the latest guidance for road network planning and street design. As subjective data was critical, the following resources also served as important resources to define data needs:

- TfNSW Cities and Revitalisation – Great Places Toolkit (NSW Government, 2024b)
- NSW Safer Cities Report (NSW Government, 2023b)

The information presented in these sources highlighted the importance of collecting place data and gathering perception data, especially in the context of safety. Though objective data may reveal safe conditions, if the perception of safety is not aligned, the location may not be achieving the intended functionality.

Table 1 presents a summary of data requirements for the project. Rows highlighted in blue indicate data sets that were used for the macroscopic analysis. Crash statistics, near miss data and speed data was available for the entirety of state through TfNSW and Compass IOT (provider of connected vehicle data). Vehicle, pedestrian and cyclist volumes are not collected systematically across the state. Vehicle volume estimations were gathered from the Sydney Travel Model. TfNSW Walking and Cycling counts were collated acknowledging that these are estimated volumes using the model developed by Saberi and Lilasathapornkit (2024). Opal Card data was not accessible for the project. This would have provided revealed information of public transport usage at a region-based aggregation (i.e. Statistical Area Level 2 (SA2) or Local Government Area (LGA) spatial aggregation), however due to inaccessibility, subjective usage data was gathered through the face to face and online questionnaire surveys. In addition, the questionnaire surveys provided direct feedback regarding public perception concerning the functionality, design and safety of the case study sites. In terms of detailed objective data, Trans Traffic Survey (TTS) company was contracted to gather data for the case-study sites, including volumes, speeds and pedestrian dwell times. Further details of the data are described in the following sub-sections of the report.

Table 1: Summary of data requirements, sources and level of aggregation (blue shaded rows were data sets used for the macroscopic analysis)

Data	Data Source	Level of Aggregation	Comments
Crash statistics	TfNSW Crash data base	Individual crashes, state-wide between 2019 and 2023	
Near misses/close interactions (between road users and vehicles/cyclists/public transport)	Compass IOT	Individual events involving vehicles requiring a rapid evasive manoeuvre (braking, steering or combined actions).	
Public transport usage (bus/light rail/suburban rail use)	TfNSW Opal Card Data	Station demands aggregated to 15-minute intervals.	***Opal Card data was not made available for this project.*** Self-reported usage data was collected through questionnaire surveys.
Volume of vehicles (including vehicle classes)	Sydney Travel Model (STM) Outputs TTS data collection (for 12 sites)	SCATS data from 7 sites in Manly at an hourly aggregation (Four weeks of data) STM link level outputs from 2021 model run. TTS data from 12 case study sites, hourly data gathered across 1 week period.	***Modelled volumes of key links across the state were used for the macroscopic analysis (STM outputs).*** Case study evaluation leveraged TTS data.
Speeds of vehicles	Compass IOT	Link level speeds available across the NSW	
Volume of cyclists	TfNSW Walking and Cycling Counts (Estimated volumes) TTS data collection (for 12 sites)	SA2 and LGA estimations of average daily volumes. TTS data from 12 case study sites, hourly data gathered across 1 week period.	***Modelled volumes*** Case study evaluation leveraged TTS data.
Volume of pedestrians	TfNSW Walking and Cycling Counts (Estimated volumes) TTS data collection (for 12 sites)	SA2 and LGA estimations of average daily volumes. Case study evaluation leveraged TTS data.	***Modelled volumes*** Case study evaluation leveraged TTS data.
Pedestrian dwell times	TTS data collection	Data collection on 1-day, between 07:30 and 16:30 across 12 case study sites.	
Perceptions related to street/road functionality	Questionnaire Surveys	N/A (Gathered through online and face to face survey instrument)	
Perceptions related to design feature suitability	Questionnaire Surveys		
Perceptions related to accessibility	Questionnaire Surveys		
Perceptions related to vehicle speeds	Questionnaire Surveys		
Perceptions related to safety	Questionnaire Surveys		

2.2 Case Study Site Selection

Both intercept field (survey) and online surveys were designed to gather perception data. The intercept survey was implemented at 12 specific locations identified by the UTS Research Team and the TfNSW Working Group to gather peoples' experiences at the selected sites.

Site selection was informed by the latest version of the Design of Roads and Streets (DORAS) manual and advice provided by the TfNSW Working Group. The DORAS manual presents a comprehensive categorisation of the different road and street typologies a practitioner could design and implement in different contexts. The UTS Research Team deemed the following typologies suitable for the implementation of shared road infrastructure based on the definitions provided in the manual (NSW Government, 2024a).

1. **Destination High Streets** – "*vibrant with an intense sense of place, supported by multimodal movement at low speeds and volumes*"
2. **Local Streets**
   - 2.1. **Residential Lanes** – "*Quiet, narrow streets aligned to the rear of residential properties for service access, paired with parallel residential streets can be designed for safer and more continuous links for walking and cycling*"
   - 2.2. **Residential Ways** – "*A very quiet residential street inviting for people to spend time in, often with an informal layout and a sharing of spaces, and a low speed and volume of movement*"
   - 2.3. **Neighbourhood Streets** – "*a quiet residential street for people to spend time in an environment with a low speed and volume of movement*"
   - 2.4. **Yield Streets** – "*A very quiet residential street for living activities and movement at low speeds and volumes, with a carriageway that requires people driving vehicles to yield to on another to pass*"
3. **Connector Streets** – "*A local street that connects neighbourhoods, linking residential areas with local destinations such as centres, schools and transport hubs*"
4. **Intersections within shared environments** – Located within a shared environment, generally occurring at intersections with other road segments acting as an entry / exit or connection, establishing a safe environment.

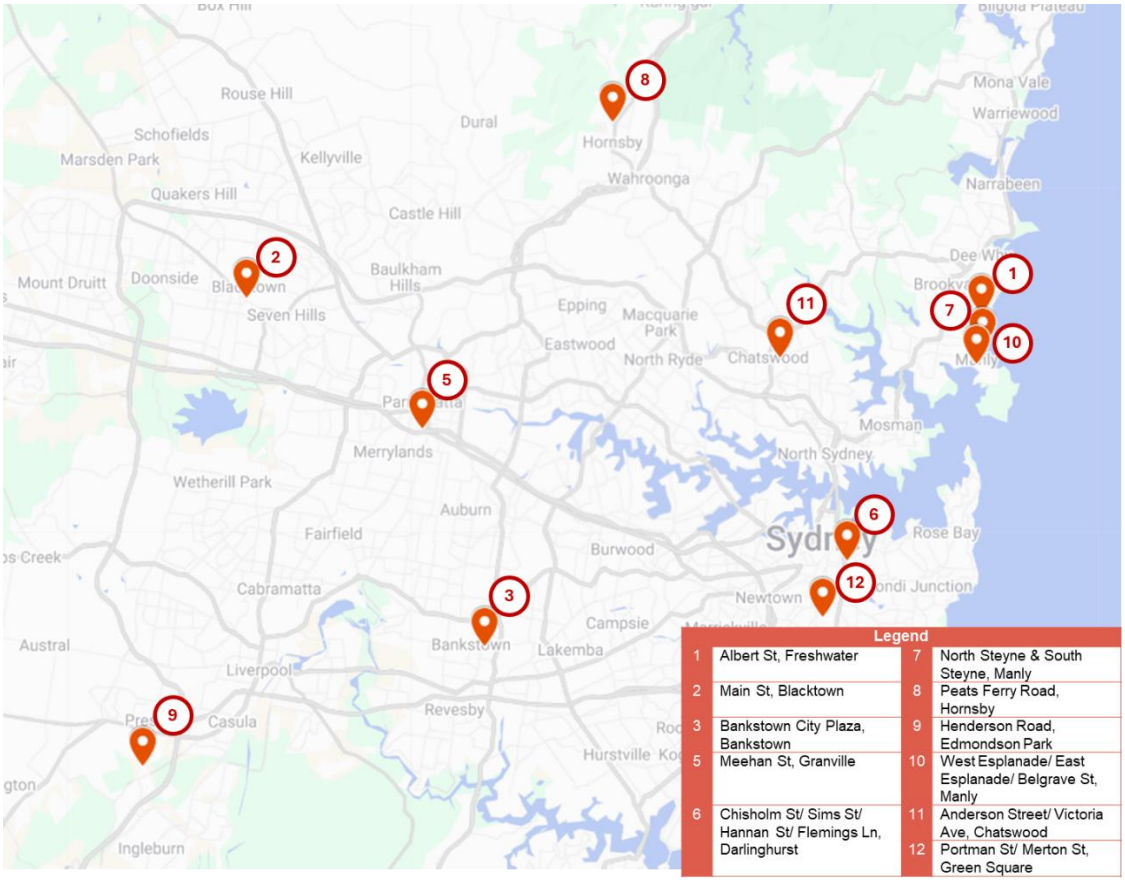
To manage resourcing constraints to collect subjective field data, typologies 2.1 to 2.4 were considered as a cluster as they have very similar definitions as highlighted above. However, an additional typology is proposed for data collection, "***Intersections in shared environments***" as all the above typologies require entry and exit treatments which generally occur at intersections with other road segments. In addition, some shared spaces span multiple road links and intersection management is key to ensuring the safety and effectiveness of the shared environment.

Table 2 presents the finalised Case study sites for survey implementation. A set of control sites were identified where 3 out of the 4 sites are in located in the Northern Beaches of Sydney (Manly and Freshwater). Two of the sites, N Steyne/S Steyne and the intersection of West Esplanade/East Esplanade and Belgrave Street, are specifically near "The Corso" area which has undergone a series of transformations to achieve a low-speed environment of 30km/h. The other control site, Chisholm Street/ Sims Street/ Hannan Street/ Flemings Lane, Darlinghurst (referred to as Chisholm Street, Darlinghurst moving forward), are a set of shared zones "Neighbourhood Street/Residential Way" with a speed limit of 10km/h, offering a baseline for comparison with the other sites. One of the locations is a Private Street and to ensure confidentiality is maintained, it will be referred to across the report as "Private Street, greater Sydney area". The remaining sites are located across the greater Sydney area extending to the North-West, West, and South-West of Sydney, as shown in Figure 5.

Table 2: Case study sites

Typology	Control Sites	Other Sites	
Destination High Streets	**Albert Street, Freshwater (D1)** • High pedestrian activity area (**40km/h**) • Supports social activity.	**Main Street, Blacktown (D2)** • High pedestrian activity are (**40km/h**) adjacent to Blacktown Train Station and other commercial properties. • Narrow road infrastructure, limited parking.	**Bankstown City Plaza, Bankstown (D3)** • Defined shared zone (**10km/h**). • One-way road – restricted vehicle access. • A key street connecting neighbourhoods to Bankstown centre.
Residential Lanes/ Residential Ways/ Neighbourhood Streets/ Yield Streets	**Chisholm Street/ Sims Street/ Hannan Street/ Flemings Lane, Darlinghurst (R1)** • Defined shared zone (**10km/h**). • Yield Street with narrow lanes within a residential area, adjacent to low density housing.	**Meehan Street, Granville (R2)** • Standard suburban neighbourhood street **(50km/h).** • 2-way road with footpaths encouraging pedestrian activity. Adjacent to residential properties and small reserve (Wallawa Reserve)	**Private Street, Sydney area (R3)** • Defined shared zone **(10km/h)**. • 2-way road with footpaths encouraging pedestrian activity. • Adjacent to residential properties only (low density).
Connector Streets	**North Steyne and South Steyne, Manly (C1)** • Defined shared space (**30km/h**) • Connects with other residential streets to the North and directs movement towards to Corso (commercial/ tourist/ activity centre).	**Peats Ferry Road, Hornsby (C2)** • Potential shared zone (**50km/h**) • Connects residential areas (e.g. Hornsby Heights) with a transport centre.	**Henderson Road, Edmondson Park (C3)** • High pedestrian activity area (**40km/h**) • A 2-way street connecting MacDonald Road and Soldiers Parade, consists of a bus route, adjacent to retail and Edmonson Park Station.
Shared Intersections	**West Esplanade/ East Esplanade/ Belgrave Street, Manly (I1)** • Within a defined shared space **(30km/h).** • High pedestrian activity intersection adjacent to places and shared environment.	**Anderson Street/ Victoria Avenue, Chatswood (I2)** • **40km/h** speed environment. • High pedestrian activity intersection adjacent to shopping and Chatswood Train station.	**Portman Street/Merton Street, Green Square (I3)** • **40km/h** speed environment. • Recently transformed intersection in a suburban environment.

(Note: Parentheses indicate the Site ID for each case study)



(Note: Site 4, Private Street, Greater Sydney is excluded in the above map)

Figure 5: Locations of case study sites

2.3 Objective Data

2.3.1 Collated Data

The project leveraged several existing datasets made available through NSW Government and industry partners, as identified in Table 1. These sources provided large-scale, systematically captured information that enabled macroscopic and comparative analysis across the state. Details of the data can be summarised as follows:

- **Crash statistics (TfNSW Crash Database)**: Individual crash records between 2019 and 2023 were accessed, covering all reported incidents across NSW. These data included location, time, severity, and road user involvement, providing the basis for understanding safety outcomes across the network.
- **Vehicle volumes (Sydney Travel Model outputs)**: The STM provided modelled volumes for different vehicle classes across key links at a state-wide scale. These data were critical for understanding background traffic demand in the macroscopic analysis.
- **Vehicle speeds (Compass IOT)**: Link-level speed data across NSW were sourced from Compass IOT, which aggregates high-frequency GPS data from connected vehicles and telematics providers. This data provides a sample representation of network performance and was used to correlate against other safety measures (crash statistics).
- **Near misses/close interactions (Compass IOT)**: Individual-level interaction events involving vehicles and other road users were collated. These data captured instances of harsh braking, rapid acceleration, or other conflict indicators, providing a leading measure of potential safety risks before crashes occur.

- **Cyclist volumes (TfNSW Walking and Cycling Counts)**: Estimated daily volumes at the SA2 and LGA level were collated. These broad-scale indicators provided a useful benchmark for understanding cycling activity within different parts of the state.
- **Pedestrian volumes (TfNSW Walking and Cycling Counts)**: Estimated average daily pedestrian volumes at SA2 and LGA level were sourced. As with cyclist data, these indicators provided a baseline understanding of walking activity at an area level, which could then be compared with more detailed local counts.

2.3.2 Collected Data

Complementing the collated datasets, targeted data collection was undertaken at the 12 case study sites by TTS. This additional data source offered detailed, site-specific revealed information about traveller behaviour and network performance. As indicated in Table 1, the collection focussed on multimodal volumes, speeds and pedestrian activity patterns, and was conducted in coordination with the intercept surveys to allow for accurate comparison between subjective and objective data. All objective data collection occurred during March and April 2025, deliberately scheduled to avoid NSW School Holiday and Easter periods to ensure typical travel conditions. The following data was collected:

- **Traffic volumes and speeds (motor vehicles and bicycles)**: Pneumatic tube counters were deployed at each site to **gather continuous data over a one-week period**. These counters measured both traffic volumes (including vehicle classes and bicycle flows) and speeds, enabling detailed temporal profiles of network performance across weekdays and weekends.
- **Pedestrian volumes and dwell times**: Pedestrian activity was measured using video analytics technology. Cameras were positioned at key street segments and intersections to capture hourly pedestrian flows over the same one-week period as the traffic counts. Automated analytics were applied to the footage to ensure consistency and reduce manual counting error. Video analytics were also used to capture dwell times, defined as the duration of pedestrian presence within a defined area of the street environment.
- Data were collected between **07:30 and 16:30 on a nominated weekday at each site (coinciding with the implementation of the intercept survey)**, providing a representative insight into patterns of stationary activity and use of public space.

Together, these locally collected datasets provided the site-specific evidence required to complement the broader collated datasets, ensuring that both macro-level patterns and micro-level behaviours were captured in the evaluation.

2.4 Subjective Data: Survey Development

Road network performance can be assessed using revealed objective data sets (such as those outlined in the previous section), however subjective data gathering user perceptions is equally valuable to improve road safety and enhance places (Hamilton-Baillie, 2008; Müggenburg et al., 2022). Accordingly, two complementary questionnaire surveys were designed and implemented to gather subjective data. The intercept survey was delivered in-person through intercept surveys at the 12 case study locations, while the other was made available online to broaden the reach and inclusivity. Collecting both forms of data was essential: intercept surveys enabled engagement with people directly using the case study locations, while the online instrument allowed the collection of responses from a wider cross-section of the community, representative of all residents of NSW. This dual approach ensured contextual immediacy and broader representativeness of the perception data.

The survey instruments were designed based on several recent research projects related to gathering perceptions of street safety (Castilla et al., 2024; Llinares et al., 2020; Rossetti et al., 2019). Previous studies demonstrate the diversity of methods available, from the use of street-scape imagery in online surveys (Rossetti et al., 2019), to virtual reality simulations in laboratory environments (Llinares et al., 2020) and intercept surveys with participants at the point of experience (Castilla et al., 2024). These

examples highlight the validity of the mixed approach adopted in this study, which combined both in-situ and online surveys to balance experiential validity with wider accessibility. Table 3 presents the structure of both surveys.

Table 3: Finalised structure of questionnaire surveys (Intercept survey and online survey)

Intercept Survey	Online Survey

• **Part 1: Participant Information & Consent Form**
• **Part 2: Functions**
  o Participants are asked to provide their rating for different functions of the street.
  o ***"How easy or hard is it to perform the following activities on the street we are currently standing on?"***
  o Functions: walking, running, cycling, resting, sitting, etc.
• **Part 3: Design Attributes**
  o First, participants are asked to provide their rating for different attributes of the street.
  o ***"How would you rate the following aspects for the street we are currently standing on?"***
  o Attributes considered: public transport, areas for cyclists, number of pedestrians, etc.
  o At the end, participants are asked to provide their overall rating for the street:
  o ***"Overall, the street we are standing one is very unsuitable/ unsuitable/ neither/ suitable/ very suitable for the community."***
• **Part 4: Pedestrian Safety**
  o Participants are asked to rate the safety of pedestrians with regards with crime & violence and for interactions with cyclists, motorcyclists, motor vehicles.
• **Part 5: Safety & Speed Assessment**
  o First, participants are asked about the appropriate speed limit for motor vehicles (10, 20, 30, 40, 50, 60 km/h or other).
  o At the end, participants are asked to provide their overall rating for the street:
  o ***"Overall, the street we are standing one is very safe/ safe/ neither/ unsafe/ very unsafe for the community."***
• **Part 6: Transport Modes**
  o Participants are asked about the frequency in which they use public transport, cycle, motorcycle, travel as a passenger, and drive a car. For all answers other than "never", a follow up question regarding the safety for that transport mode with regards to other modes is presented.
• **Part 7: Demographics**
  o Age, employment status, occupation, household income, residential zip code, and gender.
• **Part 8: Text box for additional comments or suggestions (optional)**
	• **Part 1: Participant Information & Consent Form**
	• **Part 2: Demographics**
	  o Age, employment status, occupation, household income, household arrangement, residential zip code, and gender.
	• **Part 3: Functions**
	  o Participants are asked to provide their rating for different functions of the street.
	  o ***"How easy or hard is it to perform the following activities in streets like the one shown above?" (image is presented)***
	  o Functions: walking, running, cycling, resting, sitting, etc.
	• **Part 4: Design Attributes**
	  o Participants are asked to select and then rank the five 5 key aspect that most often require improvements in streets.
	  o Attributes considered: public transport, areas for cyclists, number of pedestrians, etc.
	• **Part 5: Safety**
	  o Participants are asked about the safety for pedestrians, cyclists, motorcyclists, car passengers, and car drivers with regards to the other modes.
	  o Participants are asked to select and then rank the five 5 key aspect that most often require improvements in streets.
	  o Aspects considered: interactions with cyclists (as a pedestrian), interactions with motorcyclists (as a car driver), etc.
	• **Part 6: Speed assessment**
	  o First, participants are asked about the appropriate speed limit for motor vehicles (10, 20, 30, 40, 50, 60 km/h or other).
	• **Part 7: Feelings**
	  o Participants are asked to select and rank the 3 key words they associate to streets
	  o Words provided: sad, happy, ugly, beautiful, etc and 3 open-ended text boxes.
	• **Part 8: Transport Modes**
	  o Participants are asked about the frequency in which they use public transport, cycle, motorcycle, travel as a passenger, and drive a car.
	• **Part 9: Text box for additional comments or suggestions (optional)**

The core part of both surveys was structured around three interconnected levels of users' experience of a street. These were:

i. **Feelings (affective responses)**: how safe, comfortable, or pleasant a street feels.
ii. **Functionality**: how well the street supports the movement, accessibility for different users and the ability to use the infrastructure for different purposes.
iii. **Design Attributes**: the presence and suitability of specific features such as street furniture, landscaping or crossing infrastructure.

In addition to these domains, participants were asked a series of demographic questions to contextualise their responses. The three-level structure provided a systematic way of organising perceptions, enabling analysis of both the proportions of responses within each domain and the correlations between them. For example, patterns could be identified not only within affective perceptions of street "feel," but also in how these were linked to functional performance or specific design features of the street environment.

The survey design is based on the theoretical background of "***Evidence Based Design***" which is defined by the principle that outcomes (performance) are based on the built environment that surrounds the activity or process (Zhang et al., 2019). Therefore, empirical studies examining these relationships can create knowledge to enable a scientifically informed decision-making process in design. Past examples of this rationale in survey design are present in healthcare infrastructure and schools design (Barrett et al., 2013; Stichler & Hamilton, 2008) that requires the careful consideration of vulnerable users and accessibility, consistent with the context of delivering effective shared road infrastructure.

The intercept survey featured a series of 5-point Likert scale questions addressing street functions, attributes, and perceived safety for various transport modes – including pedestrians, cyclists, motorcyclists, car passengers, and drivers. Respondents are only asked safety-related questions for the transport modes they personally use, particularly in relation to interactions with other road users. The survey also gathers views on appropriate vehicle speeds and collects basic demographic information such as age, gender, employment status, and household income.

The online version of the survey covers the same core themes but is adapted for a digital or non-physical experience of streets. Instead of responding to real-world conditions, participants were provided with images of street environments while completing the survey. The same 12 case study sites are used, with each respondent randomly assigned images from one site. Demographic questions were presented at the beginning to screen participants and ensure the sample meets representativeness quotas for New South Wales (NSW) before proceeding to the full survey.

In the online version, the *Attributes* and *Safety* sections required respondents to select and rank five items from a predefined list (mirroring the items assessed in the intercept survey). This format captures both the perceived importance and satisfaction with various street elements and safety concerns. Part 8 of the survey focuses on transport mode frequency, enabling comparisons between the significance respondents place on user interactions and their actual use of different transport modes (e.g., walking, cycling, motorcycling, or traveling by car).

Converting the *Attributes* and *Safety* sections from Likert-scale responses (used in the intercept survey) to a ranking format significantly reduced the length of the online survey. This allowed for the addition of Part 7, which explores respondents' perceptions of street environments.

2.4.1 Intercept Survey Development

The development of the intercept survey followed an iterative process, incorporating both informal piloting and structured rounds of testing to refine the instrument for clarity, accessibility, and practicality of implementation. The final version of the survey is in **Appendix A**.

The initial draft survey included all three “levels of experience” described earlier and presented in in Table 3 (*Functions, Attributes* and *Feelings*). This version of the survey was piloted in collaboration with the City of Sydney (CoS) during their planned upgrades to Loftus Street, Customs House Lane and Reiby Place near Circular Quay (City of Sydney, 2024). These works included the pedestrianisation of the northern end of Loftus Street and the conversion of the intersection of Reiby Place and Loftus Street into a shared street environment. Recognising the alignment with the UTS Shared Spaces Research Program, CoS requested guidance on both objective and subjective data collection methods to evaluate the proposed upgrade. UTS researchers provided advice on data requirements and offered a draft version of the intercept survey for piloting.

The pilot was conducted at two locations (the corner of Reiby Place and Loftus Street, and the intersection of Loftus Street and Customs House Lane) using a pen-and-paper format administered by a third-party traffic survey company. Data were collected on Thursday 22 August and Saturday 24 August 2024, totalling seven hours of survey activity. Of the 341 people approached, 36 surveys were completed and a further nine partially completed, yielding a response rate slightly above 10%. Feedback from the administration team and participants highlighted that the survey required 15–20 minutes to complete, which was considered lengthy for an intercept instrument. This finding, together with logistical considerations, confirmed the value of transitioning to an electronic format (tablet or smartphone) to improve efficiency and reduce respondent burden. In addition, the structure of the survey was altered to focus on *Functions* and *Attributes* and refer to *Feelings* in the context of overall safety and suitability of the street design, rather than have explicit questions. This change reduced the length of the survey to between 10 and 15 minutes.

Following this initial pilot, a series of structured refinement rounds were conducted:

- **Round 1 (informal testing)**: The version tested by the CoS was also trialled with six individuals outside the fields of Civil Engineering and Transport. Feedback from this round reflected that of the CoS pilot and this led to major revisions in the wording and question flow to ensure clarity for a general audience. As mentioned above; to reduce the survey length, the *Feelings* component was removed at this stage.
- **Round 2 (professional review)**: The revised survey was reviewed by two industry professionals experienced in teamwork and organisation consulting. Their feedback was valuable in restructuring the Likert-scale question to reduce potential bias. For example, items were rephrased from evaluative agreement statements to rating-style prompts:
    - “***Public transport on the street we are currently standing on is appropriate***” with response options ranging from “*strongly agree*” to “*strongly disagree*” was changed to “***Rate the public transport on the street we are currently standing on***” with response options ranging from “*very suitable*” to “*very unsuitable*”.
    - To account for responder uncertainty, an **“I don’t know”** option was also added**.**
- **Round 3 (TfNSW Working Group review):** The TfNSW Working Group, reviewed the revised survey and suggested improvements to wording, readability, and formatting. Attention was given to ensuring ergonomic display on the table devices, including experimenting with different presentation formats (grids or lists) within Qualtrics.
- **Round 4 (proofreading and consistency):** A final review was undertaken by the research team to identify typographical errors and ensure consistent use of terminology across repeated elements in the Qualtrics platform. This was crucial given the multiple rounds of edits and reformatting.

Importantly, this process not only improved the rigour of the instrument but also ensured its practical suitability for deployment in real-world field conditions.

2.4.2 Online Survey Development

Building on the intercept survey, the online instrument was developed to leverage the four refinement rounds and early field findings. While both instruments cover the same core domains (Functions, Design Attributes, Safety, Speed Assessment and Demographics), the online format required targeted adaptations so respondents could make valid judgements off-site rather than experiencing the site in-situ. The final version of the online survey is presented in **Appendix B**.

The key design adaptation for the online survey included:

- **Context scaffolding via imagery and text captions**: Because respondents were not physically present at the 12 case study sites, the online survey used representative photos and concise descriptions to frame judgements to "streets comparable to those studied" rather than specific named locations. This allowed for more generalisable assessments beyond the 12 locations.
- **Prioritisation task (select and rank top five attributes)**: To reduce completion time and improve comparability, Likert-ratings questions regarding the suitability of design features were replaced with a prioritisation task. For example:
    - "***How would you rate the following aspects for the street we are currently standing on***" with ratings ranging from *"very suitable"* to *"very unsuitable"* for each attribute (public transport accessibility, areas for cyclists, number and/or speed of cyclists, etc.) was changed to "***Select and rank the 5 key aspects that most often need improvements in streets like the one shown above***" and respondents select from the same list of attributes highlighted above.

  This approach reduces scale-use bias and highlights relative priorities by requiring participants to rank their top five aspects rather than rate all as "very important." The attribute list matched the intercept survey for comparability, with randomised order and "Other/Not sure" options provided.
- **Safety interactions across modes (pairwise matrix)**: The online survey asked respondents to evaluate perceived safety between every pair of modes, independent of the respondent's own typical mode choice (e.g. using the street as a pedestrian considering interactions with cars, using the street as a car driver considering interactions with pedestrians). This allowed comparisons between users and non-users of a mode, improving the interpretability of perceived conflict even where personal experience is limited.
- **Reintroduction of the "Feelings" component**: Adjusting to a shorter, rank-based format created space to re-include an explicit affective module referencing established descriptors of streetscape experience (e.g. "happy", "noisy", "beautiful" based on prior research by (Quercia et al., 2014)), plus three open text boxes for respondent-supplied terms. This kept the questions grounded in real-world street use while keeping respondent effort low.
- **Inclusion of "Heavy Vehicle Driver" responses**: Heavy vehicle drivers were added as a distinct mode category with both the "top five safety concerns" selection/ranking and the pairwise safety matrix, reflecting stakeholder interest and observed freight interactions at some of the 12 case study sites.

Further to the above structural changes to the questionnaire, there were some refinements of the demographic questions for enhanced analytic resolution:

- **Clarification of income bands**: The previous broad income band was refined by splitting $45,001-$190,000 into $45,001-$135,000 and $135,001-$190,000, yielding a more even distribution for subgroup analysis.
- **Household arrangement**: A new item captured living situation (e.g. living alone; with partner; with partner and children; single parent with children, etc.). This addition enhances the capacity to understand how household context may influence perceptions of safety (e.g., whether adults with children report greater concern for pedestrian safety).

Together, these adaptations preserved conceptual alignment with the intercept survey instrument while ensuring that online responses were valid off-site, efficient to complete, and analytically comparable, thereby extending perception measurement beyond the 12 case study locations to a broader, generalisable context.

2.5 Subjective Data: Survey Implementation

Data collection for both survey instruments was implemented using the Qualtrics interface. The intercept (face-to-face) survey yielded 641 complete, valid responses across the 12 case-study streets (Table 4). The online survey deployed and administered by Qualtrics'. More than 1600 respondents were recruited. Participants were recruited to complete responses evenly across the 12 case study sites and reflected a representative sample of the NSW population. The anonymised data set gathered by Qualtrics was then provided to UTS (Table 4).

Table 4: Completed and valid questionnaires per street for intercept and online surveys

Case study site	Intercept Survey	Online Survey
Albert Street, Freshwater	62	128
Main Street, Blacktown	39	153
Bankstown City Plaza, Bankstown	40	142
Chisholm Street, Darlinghurst	47	145
Meehan Street, Granville	25	132
Private Street, Sydney Metropolitan	24	143
N Steyne and S Steyne, Manly	75	141
Peats Ferry Road, Hornsby	97	134
Henderson Road, Edmondson Park	56	139
Esplanade/Belgrave Street, Manly	54	142
Anderson Street/Victoria Av, Chatswood	47	138
Portman Street/Merton Street, Green Square	75	139
Total	**641**	**1676**

2.5.1 Intercept Survey Implementation

The intercept survey across the 12 case-study sites was undertaken between 1 March and 13 April 2025 (Table 5). To capture variation in use across the week, data collection was scheduled in three shifts:

- **Weekday lunchtime** (12:00–3:00 pm)
- **Weekday afternoon** (3:00–6:00 pm)
- **Weekends** (10:00 am–2:00 pm)

Fieldwork was delivered by teams of two or three surveyors from both UTS and SCT Consulting (partner organisation). All personnel wore clearly branded identification (shirts and badges) to support visibility and gain public rapport, and two A-frame signs with survey prompts and QR codes were placed at each site to encourage participation (Figure 6). Two chairs were provided at each location to offer a comfortable space for respondents to sit while completing the survey.

Each on-site team comprised two to three members: two administered the survey on tablets, while a third focused on engaging passers-by, explaining the study, and directing people to the QR codes (including those on the A-frames). Prior to deployment, two joint training sessions were held (one on campus and one at a partner office) to familiarise staff with the questionnaire, tablet interface, and field protocols.

Table 5: Intercept survey implementation

Date	Location	Timing
Saturday, 1 March 2025	Portman Street/Merton Street Green Square	Weekend
Sunday, 2 March 2025	Chisholm Street, Darlinghurst	Weekend
Tuesday, 4 March 2025	Albert Street Freshwater	Weekday
Tuesday, 4 March 2025	Private Street, Sydney Metropolitan	Weekday
Wednesday, 5 March 2025	N Steyne and S Steyne, Manly	Weekday
Wednesday, 5 March 2025	West Esplanade/East Esplanade/Belgrave Street, Manly	Weekday
Saturday, 8 March 2025	Albert Street Freshwater	Weekend
Sunday, 9 March 2025	Private Street, Sydney Metropolitan	Weekend
Wednesday, 12 March 2025	Chisholm Street, Darlinghurst	Weekday
Wednesday, 12 March 2025	Portman Street/Merton Street Green Square	Weekday
Thursday, 13 March 2025	Anderson Street/Victoria Avenue, Chatswood	Weekday
Saturday, 15 March 2025	N Steyne and S Steyne, Manly	Weekend
Sunday, 16 March 2025	West Esplanade/East Esplanade/Belgrave Street, Manly	Weekend
Tuesday, 18 March 2025	Peats Ferry Road, Hornsby	Weekday
Tuesday, 18 March 2025	Meehan Street, Granville	Weekday
Wednesday, 19 March 2025	Bankstown City Plaza, Bankstown	Weekday
Saturday, 22 March 2025	Peats Ferry Road, Hornsby	Weekend
Sunday, 23 March 2025	Anderson Street/Victoria Avenue, Chatswood	Weekend
Tuesday, 25 March 2025	Main Street, Blacktown	Weekday
Wednesday, 26 March 2025	Henderson Road, Edmondson Park	Weekday
Saturday, 5 April 2025	Bankstown City Plaza, Bankstown	Weekend
Sunday, 6 April 2025	Henderson Road, Edmondson Park	Weekend
Saturday, 12 April 2025	Meehan Street, Granville	Weekend
Sunday, 13 April 2025	Main Street, Blacktown	Weekend



Figure 6: Intercept survey deployment at Portman Street/Merton Street Green Square (weekend)

2.5.2 Online Survey Implementation

The sample size for the New South Wales (NSW) population, just over 8 million people, was estimated at 1,600 respondents (400 respondents for each street category) (Australian Bureau of Statistics, 2022; Montgomery & Runger, 2010). This sample size provides a margin of error of approximately ±2.5% at the 95% confidence level for statewide results, assuming simple random sampling. To enhance representativeness, the sample was stratified by region (Greater Sydney versus Rest of NSW, refer to Figure 7 for documentation of postcodes in Greater Sydney), gender, age, household arrangement, and household income, reflecting the demographic profile of the state according to the 2021 Census (Australian Bureau of Statistics, 2022). Data collection for the online survey was conducted by Qualtrics between 20 and 30 May 2025, and the final dataset was made available to the UTS research team on 2 June 2025.

Table 6: Sample stratification for online survey

		Greater Sydney* (65%)	Rest of NSW (35%)
Gender	Male	49%	49%
	Female	51%	51%
Age	18-24	11%	10%
	25-29 years	10%	7%
	30-34 years	10%	8%
	35-39 years	10%	7%
	40-44 years	9%	7%
	45-49 years	8%	8%
	50-54 years	8%	8%
	55-59 years	7%	8%
	60-64 years	7%	9%
	65-69 years	6%	8%
	70-74 years	5%	7%
	75-79 years	4%	5%
	80-84 years	2%	4%
	85 and over	3%	4%
Household arrangement	Couple family with children	48%	38%
	Couple family without children	35%	43%
	One parent family	15%	17%
	Other family	2%	2%
Income	50% of sample	up to $2,077	up to $1,434
	50% of sample	$2,078 or more	$1,435 or more

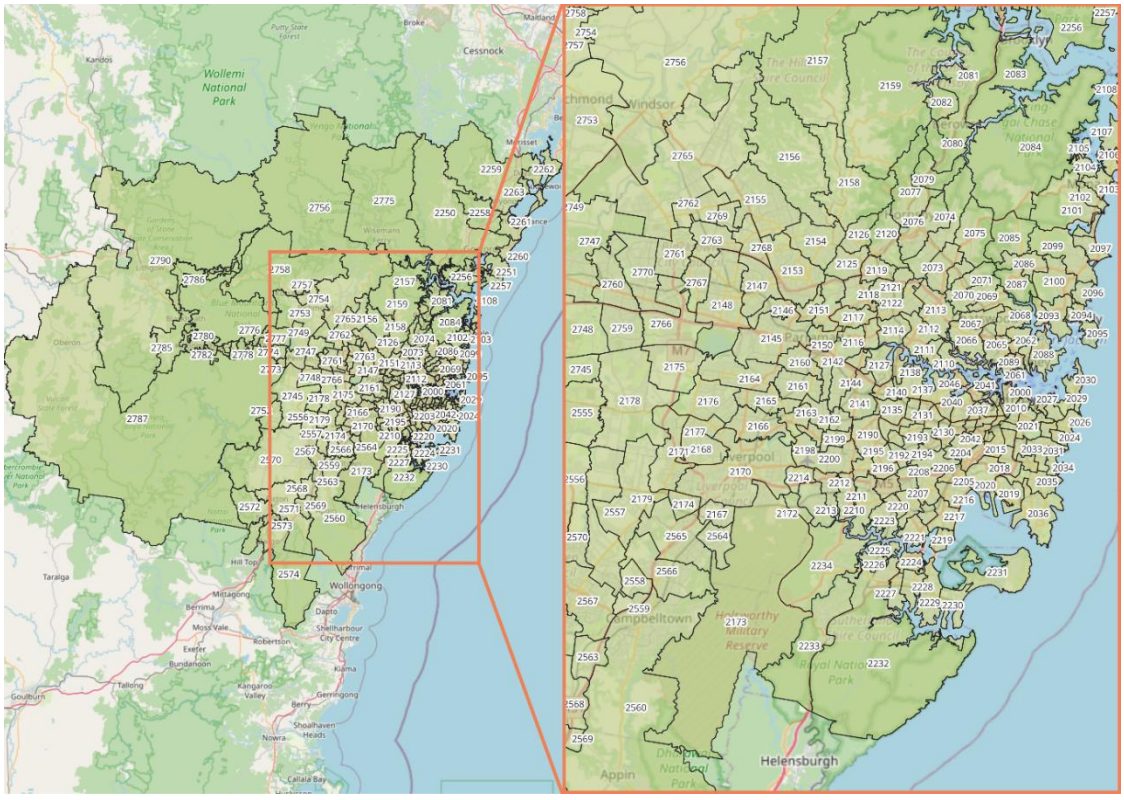


Figure 7: Identification of post-codes in Greater Sydney (used for region based stratification)

3 Macroscopic Collation and Analysis

3.1 Development of Data Platform

The development of the Shared Spaces Data Platform was undertaken to provide a consolidated, evidence-based foundation for evaluating the safety and efficiency of road environments in New South Wales. The platform integrates three key datasets: (i) crash data from Transport for NSW, (ii) speed data from Compass IoT, and (iii) near-miss data also from Compass IoT. By combining these datasets, practitioners can examine safety outcomes in relation to vehicle speeds and driver behaviour across the state, with a particular focus on shared and pedestrian-priority environments.

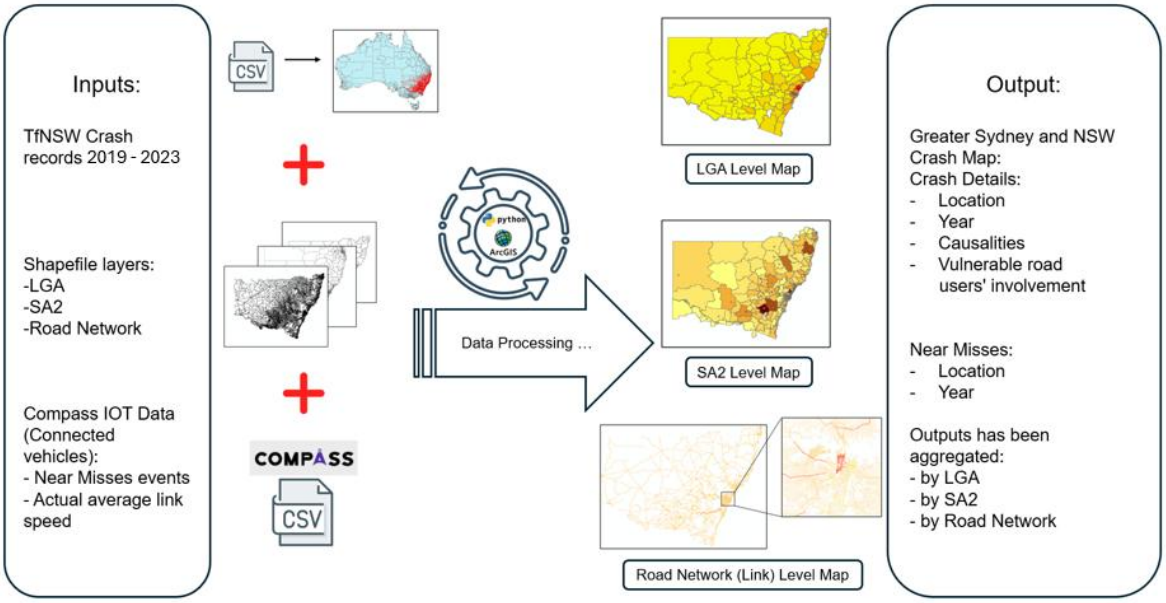


Figure 8: Database development methodology

The collation of these datasets involved a multi-stage workflow, as shown in Figure 8. First, crash data for the years 2018 to 2023 were combined into a single dataset. This process included the standardisation of attributes and the removal of duplicate entries, followed by the export of the combined dataset into CSV and shapefile formats. The data were then imported into ArcGIS, where spatial operations were used to assign each crash to its corresponding Local Government Area (LGA), Statistical Area 2 (SA2), and Open Street Map (OSM) road link. Spatial joins were used to intersect crashes with LGA boundaries and SA2 zones, while road links were assigned using proximity matching.

Once crashes were linked spatially, Python scripts were used to aggregate the data at multiple levels. For example, scripts grouped crashes by road link, by SA2, and by LGA, producing summary statistics on the number of crashes, fatalities, and injuries per location. Outputs were saved both as CSV tables and as shapefiles, allowing integration back into ArcGIS for visualisation and mapping. To address limitations in the OSM network (such as incomplete representation of smaller suburban roads), additional steps were taken to ensure that crashes occurring in boundary areas were reassigned appropriately to local links.

Compass IoT data were integrated in the next stage. Speed profiles and near-miss records were aligned with the same road link and area identifiers used in the crash dataset. This integration ensured consistency across datasets and allowed direct comparisons between speed compliance, near-miss frequency, and crash outcomes.

The final output of this process was a set of interactive layers and dashboards, enabling practitioners to interrogate data by geography (e.g., by LGA or SA2) or by network element (e.g., individual road

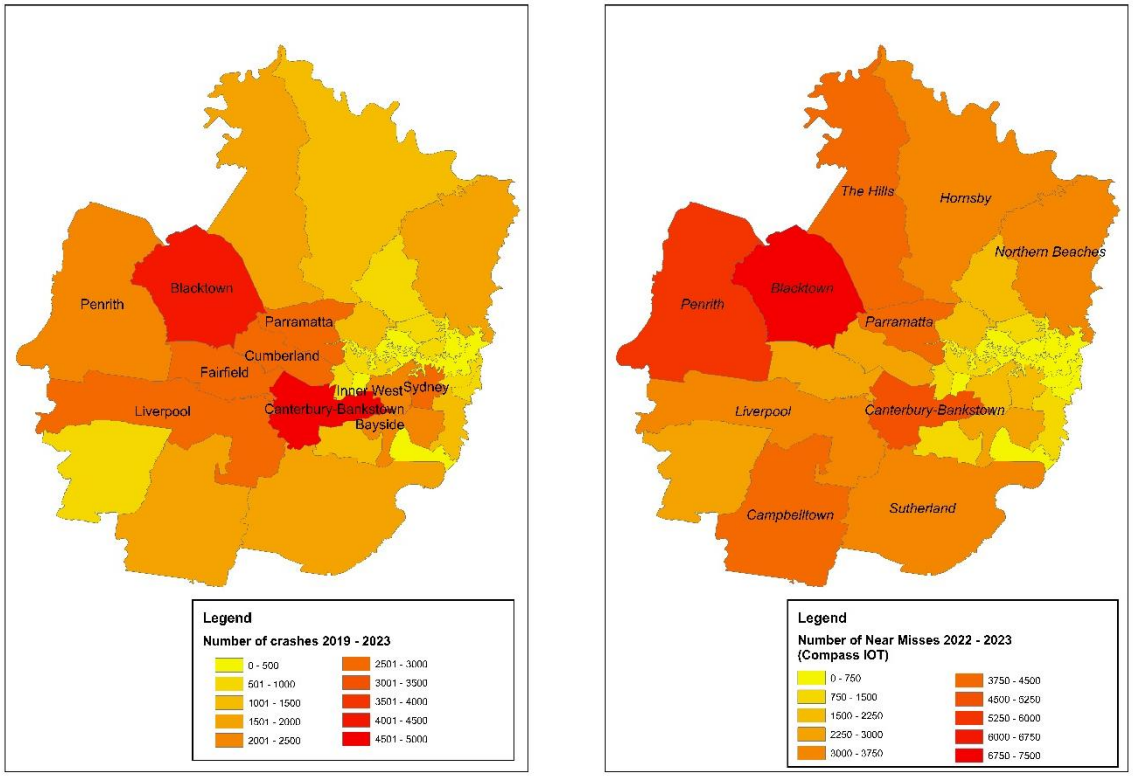
links). These dashboards provide a unique ability to connect speed management with safety outcomes, which is critical for policy and design decision-making. Beyond technical analysis, their visual and interactive nature strengthens communication with both professional stakeholders and the wider community, presenting complex statistics in an accessible format that supports transparent discussion of potential changes and evaluation of pre- and post-project outcomes.

The process was not without challenges. Incomplete representation of smaller roads in the OSM network led to some crashes initially being mis-assigned, requiring adjustments and refinements. Compass IoT data, being based on newer connected vehicles, may not fully represent all types of road users or vehicle fleets, meaning the results should be interpreted with some caution. This introduces potential socioeconomic and geographic biases, as uptake of such vehicles is lower in some communities and in regional NSW. Thus, there is value in supplementing connected-vehicle data with broader and more inclusive data sources. Despite these limitations, the integration of the datasets provides a robust foundation for analysing safety performance across the network. By bringing together official crash data with real-time behavioural indicators, the platform enables practitioners to assess risk both retrospectively and proactively.

By bringing together crashes, speeds, and near-miss data into a single spatially consistent platform, practitioners can now explore safety issues at multiple scales. This capability strengthens the evidence base for speed zoning reviews, informs infrastructure design, and ensures that shared space performance can be assessed in a more nuanced way than relying on crash data alone.

3.2 Crash Data Analysis

The analysis of crash data for Greater Sydney between 2019 and 2023 presents the safety challenges face within the metropolitan area. During this five-year period, nearly 49,500 crashes were recorded, resulting in more than 418 fatalities and around 10,500 serious injuries. These figures underline the persistent human and social costs of road trauma, even as overall crash rates have declined in some parts of the network.



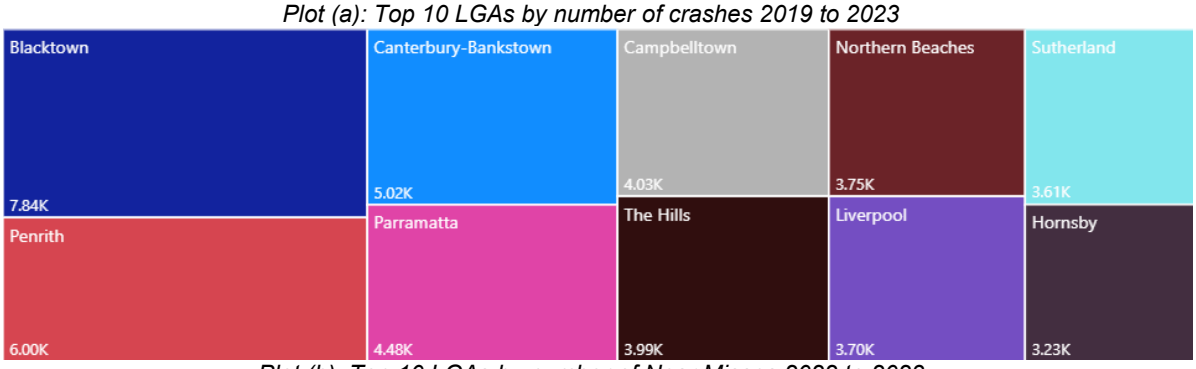
Plot (a): LGAs by Number of Crashes 2019 – 2023 Plot (b): LGAs by Number of Near Misses 2022-2023

Figure 9: Heat map of Greater Sydney LGAs based on total number of crashes and near misses.

Spatial analysis revealed a clear concentration of crashes in certain LGAs. As shown in Figure 9 and highlighted in Figure 10, Canterbury-Bankstown, Blacktown, Parramatta, Bayside, and Sydney recorded the highest absolute numbers of crashes, reflecting their large populations and high levels of vehicular activity. This pattern is further supported by Compass IOT near-miss data, which reveals a strong overlap (refer to Figure 10). Of the ten LGAs with the highest recorded near-miss incidents, five (Canterbury-Bankstown, Blacktown, Paramatta, Liverpool, and Penrith) also rank among those with the highest crash counts. However, when road length was used as a denominator to adjust for distance exposure, other LGAs emerged as disproportionately high-risk. North Sydney and Canada Bay, for example, have relatively small road networks but displayed elevated crash densities. This suggests that while total crash counts are important, normalised measures provide a more accurate picture of risk in smaller jurisdictions.



Plot (a): Top 10 LGAs by number of crashes 2019 to 2023



Plot (b): Top 10 LGAs by number of Near Misses 2022 to 2023

Figure 10: Top 10 LGA rankings for total crashes and near misses

The severity profile of crashes varied markedly across LGAs. While some areas recorded high numbers of property-damage-only crashes, others experienced a greater share of serious injuries and fatalities. Canterbury-Bankstown and Blacktown consistently exhibited the highest counts of severe outcomes, followed by Sydney, Parramatta, and Liverpool (Table 7). These results suggest that local conditions—such as higher exposure due to traffic volumes, varying road design standards, enforcement practices, and the diversity of road users—contribute to differing safety outcomes across LGAs. The temporal trends shown in Figure 11 further reinforce these disparities: although a temporary decline in fatalities and serious injuries occurred during 2020–2021, likely reflecting reduced mobility during the COVID-19 pandemic, the upward trajectory since 2022 indicates a resurgence in crash severity. Notably, Canterbury-Bankstown and Blacktown have experienced the steepest increases, highlighting the need for targeted interventions and sustained monitoring in these high-risk areas.

Table 7: Severity profile across the ten LGAs with the highest number of crashes 2019 to 2023

LGA	Total No. Crashes	No. Fatality	No. Serious Injuries	No. Moderate Injuries	No. Minor Injuries
Canterbury-Bankstown	4738	34	1075	1592	1374
Blacktown	4329	38	812	1352	1129
Cumberland	2976	25	622	939	894
Sydney	2955	26	530	998	901
Parramatta	2943	30	547	907	938
Liverpool	2887	28	611	994	853
Fairfield	2543	24	550	943	638
Penrith	2316	22	481	980	527
Bayside	2201	16	448	696	588
Inner West	2199	15	398	703	626

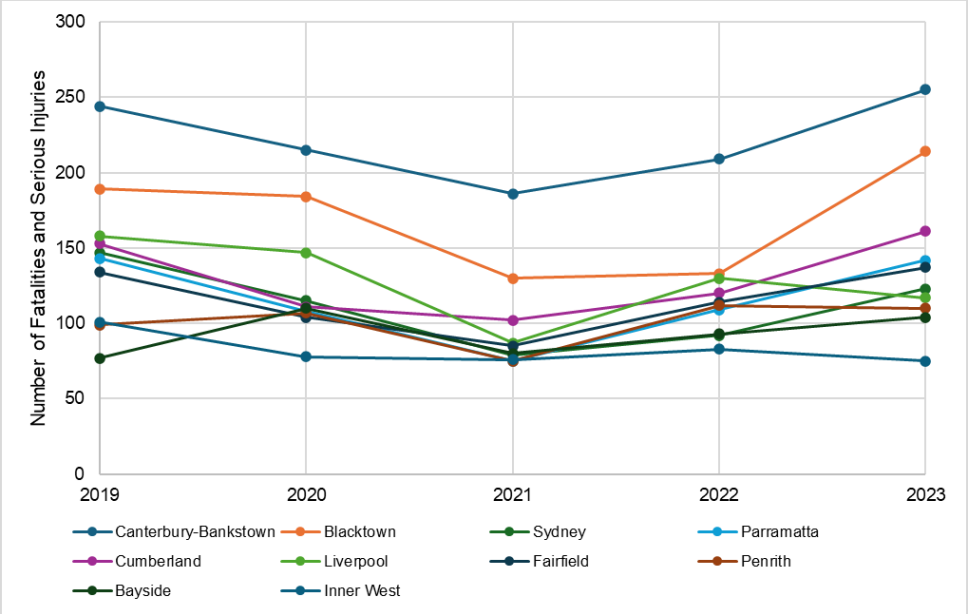


Figure 11: Annual variation in fatalities and serious injury across the ten LGAs with the highest crashes.

3.2.1 Shared Spaces and Vulnerable Road Users

One of the central aims of the project was to better understand the risks faced by vulnerable road users (VRUs), particularly in shared spaces and low-speed environments. Pedestrians and cyclists are at the greatest disadvantage in traffic collisions, as they lack the physical protection provided to vehicle occupants. Understanding the distribution of crashes within this environment is therefore essential for evaluating the effectiveness of shared zones and speed management policies. This was investigated by overlaying crash data with potential and designated shared zones and spaces within the City of Sydney LGA, as presented in Figure 12. Between 2019 and 2023, a total of 99 crashes were recorded in shared zones across Sydney. While the overall number is relatively low compared to the broader road network, these crashes provide important insight into the safety of environments designed to prioritise interaction between road users. Out of the 99 crashes, 73 resulted in injuries, with nine classified as serious injuries. Importantly, no fatalities were recorded within these environments during this period, suggesting that the very low speed environments are effective in preventing the most severe outcomes.

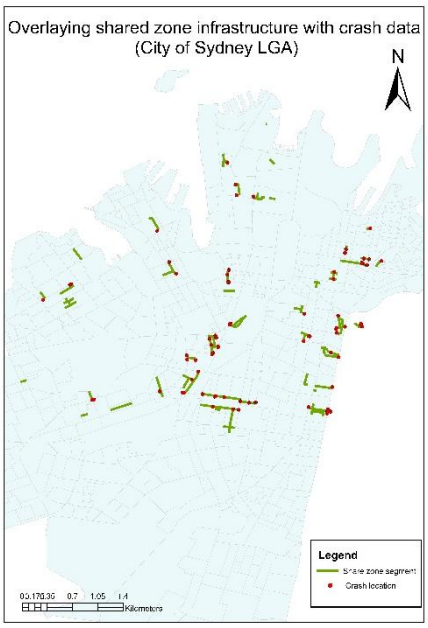


Figure 12: Mapping of shared space and zone infrastructure and corresponding crash location data within the City of Sydney.

The injury profile, however, presents a different pattern. Over 30% of crashes involved pedestrians, and approximately 25% involved cyclists or scooter riders. This high proportion of VRU involvement underscores the fact that although shared zones are successful in reducing the severity of outcomes, they are not immune from collisions. The very nature of shared zones, where vehicles and pedestrians occupy the same space, creates more opportunities for interaction, and therefore potential for conflict. As these areas evolve to enhance place qualities and attract more pedestrian activity, exposure to vehicle movements also rises, reinforcing the need for designs that ensure pedestrian priority and comply with speed-zoning requirements.



Figure 13: Shared zone at Dixon Street, Sydney

The evidence from shared zones suggests that while the policy of mixing traffic can be successful in reducing fatalities, design and management remain crucial in limiting injuries. Features such as surface treatments, narrowed carriageways, street furniture, and strong pedestrian priority cues all play a role in ensuring vehicle speeds remain low enough to minimise harm (Green et al., 2020). One notable area is Dixon Street, at the intersection with Pier Street/Goulburn Street, where 8 crashes occurred within the shared zone or near the intersection, over the five-year period. Out of these, 5 crashes involved pedestrians, leading to 1 serious injury, 5 moderate injuries, and 1 minor injury. This example highlights the importance of continued monitoring and improvements to maintain pedestrian safety in shared zones. In summary, vulnerable road users remain at elevated risk in environments where their movements intersect with motor traffic. Shared zones offer a promising approach to reducing fatal crashes, but they do not eliminate injury risk. Continued refinements to design, combined with stronger behavioural reinforcement for drivers, are needed to ensure these spaces deliver their full safety potential.

3.3 Posted Speed Limit Analysis

A detailed analysis of crashes by posted speed limit provides further insight into the relationship between speed environments and safety outcomes. Table 8 describes the distribution of crashes across the speed limits, and the trends observed are described as follows:

- **10-30 km/h:** Crashes in 10–30 km/h zones were relatively rare in absolute numbers, reflecting the small proportion of the network designated at such speeds. Though there are no fatalities observed for speed limits less than 30km/h, although a higher share of crashes resulted in injuries and disproportionately involved vulnerable road users, particularly pedestrians. This reflects the concentration of these speed environments in shared spaces and pedestrian-priority areas.
- **40km/h**: Streets posted at 40 km/h accounted for 2,811 crashes with a fatality rate of 0.64 %. Injuries were predominantly of moderate severity. These limits are typically applied to locations with higher pedestrian activity—often considered within High Pedestrian Activity Areas (HPAAs). The results reinforce that 40 km/h environments substantially reduce crash severity while accommodating pedestrian movement, consistent with Safe System speed principles showing that serious injury risk remains low below 40 km/h.
- **50 km/h**: For roads with 50 km/h posted speed limits, crash frequency increased markedly, with 17,833 crashes, the highest of any category. These streets form much of the urban network and represent the urban default local road speed limit. Although the fatality rate remained below 1%, the overall crash burden is considerable due to high traffic exposure. The proximity of this limit to 60 km/h is noteworthy, as small increases in operating speed can sharply elevate injury severity.
- **60-70 km/h**: Crash frequency declined at these limits (17,326 and 6,021 crashes, respectively), yet severity increased. Fatalities rose to 0.79–0.93 %, and the proportion of serious injuries remained high. This transition corresponds to a functional change in the road network, where higher-speed arterial corridors replace local and collector streets. Pedestrian exposure decreases, but impact energy rises rapidly once speeds exceed 60 km/h.
- **80–110 km/h**: Crashes in these higher-speed environments were less frequent but far more severe. Fatality proportions ranged from 1.38 % (at 80 km/h) to 1.54 % (at 110 km/h), with over one-fifth of crashes resulting in serious injuries. These findings align with statewide data showing that approximately two-thirds of NSW fatal crashes occur on rural roads posted between 80 km/h and 110 km/h (TfNSW, 2023). High-speed crashes typically involve fewer vulnerable road users but have far more severe consequences when they occur.

Table 8: Distribution of crash statistics based on posted speed limit accounting for crash severity

Speed limit (km/h)	Crash	Fatality (%)	Injuries (%)		
			Serious	Moderate	Minor
10	38	0	26.32	26.32	31.58
20	20	0	20.00	30.00	20.00
30	138	0	25.36	28.99	35.51
40	2811	0.64	19.25	30.24	27.85
50	17833	0.67	19.53	27.05	22.49
60	17326	0.79	19.84	29.58	28.01
70	6021	0.93	18.29	28.28	30.94
80	3191	1.38	21.50	29.71	27.70
90	442	0.68	16.29	25.34	30.54
100	1179	0.68	18.15	25.87	24.85
110	519	1.54	23.89	29.29	18.69

This distribution highlights a dual challenge. On one hand, the large number of crashes in **50 km/h and 60 km/h zones** suggests that even small speed reductions or improved compliance could yield significant safety gains by lowering overall crash incidence. On the other, the heightened severity observed from **70 km/h upwards** underscores the need for strict compliance and enforcement in high-speed environments. The analysis demonstrates that no single speed environment can be considered in isolation. While low-speed zones record relatively few crashes, the high involvement of pedestrians makes them critical to monitor. Mid-speed zones are where most crashes occur, and high-speed zones are where the most severe outcomes are concentrated. These patterns align with the Safe System speed principles and the Wramborg fatality-risk curves, which show a sharp rise in pedestrian fatality probability beyond **30 km/h** and substantially higher risks at 50 km/h and above (Wramborg, 2005). Consistent with NSW Speed Zoning Standard (NSW Government, 2025a), Section 5.3: *Speed and Fatality Risk*, the findings reinforce the need for a graduated approach to speed management that balances crash frequency and severity across the network.

3.3.1 Correlation between Crashes and Posted Speed Limits

Correlation analysis examined the relationship between posted speed limits and crash outcomes across the network. When all speed limits from 10 to 110 km/h were considered together, correlations with crashes, serious injuries, and fatalities were weak, with coefficients close to zero. However, when the analysis was restricted to the 10–70 km/h range, much stronger relationships emerged, as shown in Table 9.

Table 9: Correlation between posted speed limit and crash statistics (2019 – 2023)

Correlation	Crash	Fatality	Serious	Moderate	Minor
Speed limit 10-70 (km/h)	0.68	0.73	0.67	0.69	0.73

Within this range, the correlation between posted speed and crash frequency was 0.68, and the correlations with fatalities and serious injuries were similarly high, at 0.74 and 0.68 respectively. This indicates that in moderate-speed environments, where most urban crashes occur, even small increases in posted limits are associated with significantly higher risks of both crash occurrence and severity. The results confirm what has long been demonstrated in international research: lower speeds in urban environments directly reduce both the frequency and the severity of crashes (Mahmoud et al., 2023;

Wang et al., 2018). For practitioners, this strengthens the case for lowering limits in busy urban centres, particularly those with high pedestrian activity.

3.4 Speed Compliance Analysis

The Compass IoT speed data provided an opportunity to explore how well drivers comply with posted speed limits across the network. Unlike crash data, which reflects events after they have occurred, speed data provides insight into everyday driver behaviour, offering a more proactive lens on safety. Table 10 presents the speed compliance results across the posted speed limit range.

The results revealed a clear gradient in compliance across different speed environments. In the very low-speed zones of 10–30 km/h, often associated with shared zones, shared spaces or laneways, compliance was particularly poor (between 15% and 41% non-compliance). Across many links, the average speed exceeded the posted limit, and the 85th percentile speed was often several kilometres per hour above the threshold. This indicates that many drivers are failing to comply with these limits. In 40–50 km/h zones, compliance improved significantly, with mean and median speeds more closely aligned with posted limits. However, a substantial tail of higher speeds was still observed in some locations, suggesting that even in these environments, speed enforcement remains an ongoing challenge. Although average, median, and 85th percentile speeds generally remained within posted limits in higher-speed environments (80 km/h and above), overall compliance tended to deteriorate. The lower observed speed metrics likely reflect the influence of congestion and planned roadworks on motorway and highway networks across the state. As shown in Table 10, the compliance rate declines from approximately 94% to below 90%.

Table 10: Speed compliance percentages by posted speed limit (Greater Sydney)

Speed limit (km/h)	Average Speed (km/h)	Median Speed (km/h)	85th Percentile speeds	Proportion of vehicles exceeding the speed limit (%)
10	11.6	10.4	19.9	40.97
20	14.0	13.2	22.8	30.24
30	14.6	13.9	24.2	14.52
40	14.9	13.8	25.8	2.48
50	17.2	16.1	28.7	1.83
60	25.0	25.1	38.7	4.06
70	31.5	32.2	46.7	4.60
80	38.8	39.8	53.5	6.50
90	40.2	40.5	54.0	5.57
100	42.3	44.5	55.2	5.65
110	76.8	78.2	88.1	10.19

The compliance patterns have important implications for shared spaces and other pedestrian-priority areas. Where very low limits are introduced without strong design cues, drivers often ignore them, undermining the intended safety benefits (Williamson, 2021). Simply installing signage is rarely sufficient. Instead, compliance must be reinforced through physical and perceptual measures, such as narrower carriageways, raised crossings, landscaping, or pavement colour changes that signal to drivers that they are entering a pedestrian-oriented space. The data also raises questions about the use of the traditional “85th percentile rule” in setting speed limits (Tottadi & Mehar, 2022). Furthermore, Austroads and NSW Speed Zoning Standard discourage the use of this approach. This rule, which sets limits based on the observed behaviour of the majority of drivers, is less applicable in environments where the aim is to protect VRUs. In low-speed environments, such as 30 km/h posted areas or High Pedestrian Activity Areas (HPAAs), the appropriate response to observed noncompliance is not to raise the speed limit but to redesign the environment so that observed speeds align with safe operating

conditions. **Overall, the analysis shows that compliance is challenging for low-speed environments. For shared spaces, this means adjusting design approaches to ensure compliance is engineered into the environment rather than reliant on enforcement alone.**

3.5 Crash Risk Assessment

Crash counts provide an indicative measure of overall safety outcomes but do not account for variations in exposure or travel activity across regions. Areas with high volumes of road users, whether vehicles, pedestrians or cyclists, will naturally experience more crashes simply due to greater activity. To provide a more balanced assessment, crash data were normalised against corresponding exposure estimates for each mode. Specifically, **crash risk indices were calculated for vehicles, pedestrians and cyclists by dividing the number of reported crashes by the estimated volume of vehicle, pedestrian and cycling trips within each LGA**, as shown in Equation (1). This normalisation allowed for meaningful comparison across LGAs of varying size and activity levels, highlighting where vulnerable road users face disproportionately high risks.

$$CR_i' = \frac{CR_i - CR_{min}}{CR_{max} - CR_{min}} \quad (1)$$

$CR_i = \frac{C_i}{AEV_i}$ = Crash risk index for region "i" (for a given year)

C_i = Crash for region "i" (for a given year) (total crashes for general crash risk, pedestrian crashes for pedestrian crash risk, cyclist crashes for cycling crash risk)

AEV_i = Aggregated estimated volume of road users for region "i" (vehicular volume for general crash risk)

CR_i' = Normalised crash risk index for region "i" (for a given year)

CR_{max} = Maximum crash index across all regions considered.

CR_{min} = Minimum crash index across all regions considered

To maintain consistency in the analysis:

- Total crashes were used to assess the general crash risk associated to vehicle volumes
- Pedestrian crashes were used to assess pedestrian crash risk associated with pedestrian volumes
- Cycling crashes were used to assess cycling crash risk associated with cycling volumes.

Therefore, estimating crash risk involved the estimation of vehicle volumes and walking and cycling trips. Given the challenge in acquiring comprehensive detailed vehicle volume data across the Greater Sydney or NSW, the project used estimates of vehicle volumes from the **Sydney Travel Model (STM)** as a proxy for real world data. Specifically, outputs from ***STM4_STD_2021: Base Year_TZ21*** model were provided by TfNSW for significant links of the greater Sydney Road network. This data was aggregated at an LGA level to estimate crash indices.

Similarly, the absence of region-wide programs collecting empirical walking and cycling volume data presents a comparable limitation for estimating active travel exposure. Thus, the project leveraged the methodology by (Saberi & Lilasathapornkit, 2024), which is applied to define ***TfNSW Walking and Cycling Count*** estimations. This approach integrates multiple datasets, including observed counts, crowdsourced fitness tracking data (Strava), mobile phone location data, demographics, land use patterns, climate, and topography, to generate reliable estimates of active travel volumes across large networks. The framework applies ensemble learning methods (Gradient Boosting Regression, Voting Regression) with feature selection via LASSO, ensuring that key predictors of walking and cycling activity are identified. Corrections are made for known biases, such as the overrepresentation of recreational cyclists in Strava and the underrepresentation of short walking trips in mobile phone data, using demographic and land use adjustments. Missing data on low-activity links are imputed to maintain coverage, and cross-validation is used to ensure spatial and temporal robustness of the predictions.

Final exposure values are produced by aggregating link-level estimates to the LGA level, incorporating average trip distance assumptions (1 km for walking, 4.7 km for cycling) and effective distance factors to approximate network utilisation.

By combining these exposure estimates with crash counts from Transport for NSW (2022–2023), **crash risk indices were calculated for each LGA**. The general crash risk assessment covered all Greater Sydney LGAs, while the pedestrian and cycling analyses focused on selected Greater Sydney LGAs consistent with the coverage of the (Saberi & Lilasathapornkit, 2024) model. Additional infrastructure indicators, including the length of separated cycle lanes and the extent of low-speed road segments (≤40 km/h), were integrated to contextualise risk patterns. This macroscopic framework provided a systematic way to compare crash risk across Sydney LGAs, enabling prioritisation of locations where pedestrians and cyclists are most at risk relative to their presence on the network.

3.5.1 General Crash Risk

Crash risk analysis using vehicle exposure is a well-established approach in transport safety research and practice (Qin et al., 2025; Yasmin et al., 2018), and the approach adopted in this study aligns with established methodologies. To ensure consistency between exposure and outcome data, it was necessary to align modelled vehicle volumes with crash records from a comparable time period. Although vehicle volume estimates were available for the 2021 base year of the STM, that year was substantially affected by COVID-19 restrictions, which led to unusually low travel activity and reduced crash frequencies. Consequently, crash data from 2022 were used for the analysis. As the 2021 modelled volumes represent typical, unconstrained travel conditions not influenced by the pandemic, this pairing was considered appropriate and methodologically consistent.

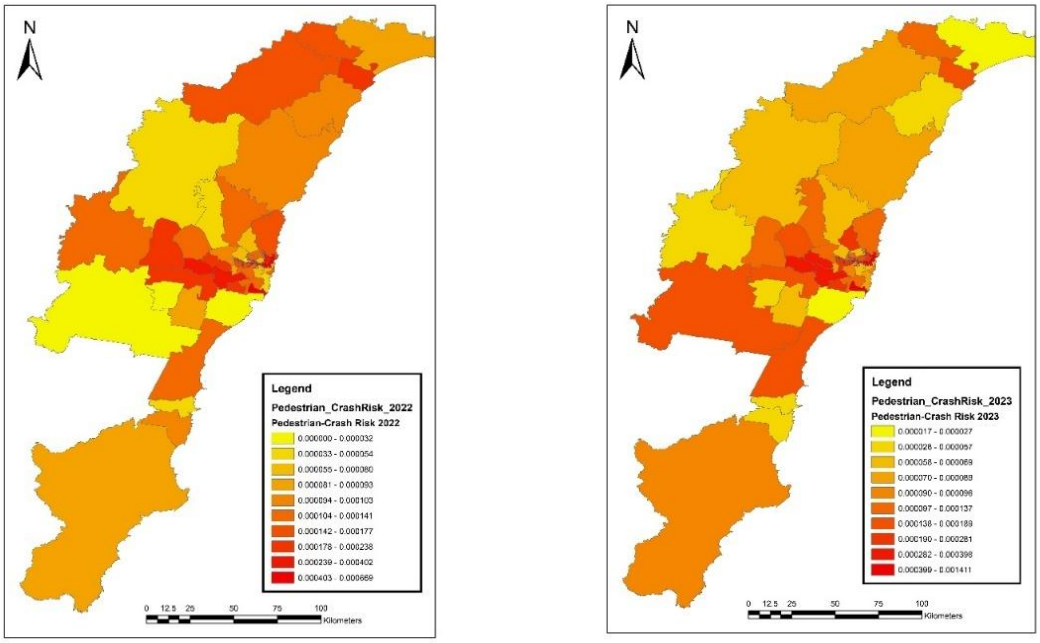
Table 11 presents two complementary rankings of Local Government Areas (LGAs): one based on total recorded crashes and the other on crash risk normalised by vehicle volumes. While Canterbury-Bankstown and Blacktown exhibit the highest absolute crash counts, the normalised results reveal a markedly different pattern. The Hawkesbury LGA, for instance, records comparatively fewer crashes in total but demonstrates the highest crash risk once exposure is accounted for, indicating a greater likelihood of crashes relative to traffic volumes. This divergence highlights the value of exposure-adjusted indicators, which provide a more equitable basis for identifying areas of elevated risk that may be overlooked when relying solely on aggregate crash counts.

Table 11: Comparison of aggregated crashes and crash risk by LGA for the Greater Sydney.

	Aggregated Crashes		Normalised Crash Risk	
Rank	**LGA**	**Total Crashes (2022)**	**LGA**	**Crash Risk**
1	Canterbury-Bankstown	865	Hawkesbury	1.000
2	Blacktown	836	Waverley	0.589
3	Parramatta	601	Wollondilly	0.503
4	Liverpool	575	Randwick	0.372
5	Sydney	556	Penrith	0.354
6	Cumberland	553	Campbelltown	0.304
7	Penrith	496	Fairfield	0.278
8	Fairfield	484	Woollahra	0.272
9	Bayside	433	Cumberland	0.254
10	Inner West	430	Canterbury-Bankstown	0.241

3.5.2 Pedestrian Crash Risk

Pedestrian crash risk was assessed for the years 2022 and 2023, corresponding to the period for which pedestrian volume estimates were most robust. The underlying model was calibrated using observed counts and crowdsourced data collected during this timeframe, ensuring temporal consistency between exposure and crash data. Figure 14 and Table 12 summarise the LGAs with the highest pedestrian crash risk. After adjusting for exposure, Canterbury-Bankstown, Fairfield, and Cumberland exhibited the greatest relative risk, with Georges River and Mosman also ranking among the top five in 2023. A high degree of consistency was observed between the two years, with eight LGAs represented in both periods of analysis. Although the City of Sydney reported a high absolute number of pedestrian crashes, its normalised risk index was comparatively moderate due to the substantial volume of walking activity in the area. A comprehensive listing of pedestrian crash risk across all Greater Sydney LGAs is provided in **Appendix C**.



Plot (a): 2022 *Plot (b): 2023*

Figure 14: Spatial heat maps of pedestrian crash risk for 2022 and 2023 by LGAs in Greater Sydney

Table 12: Ten leading LGAs according to pedestrian crash risk for 2022 and 2023

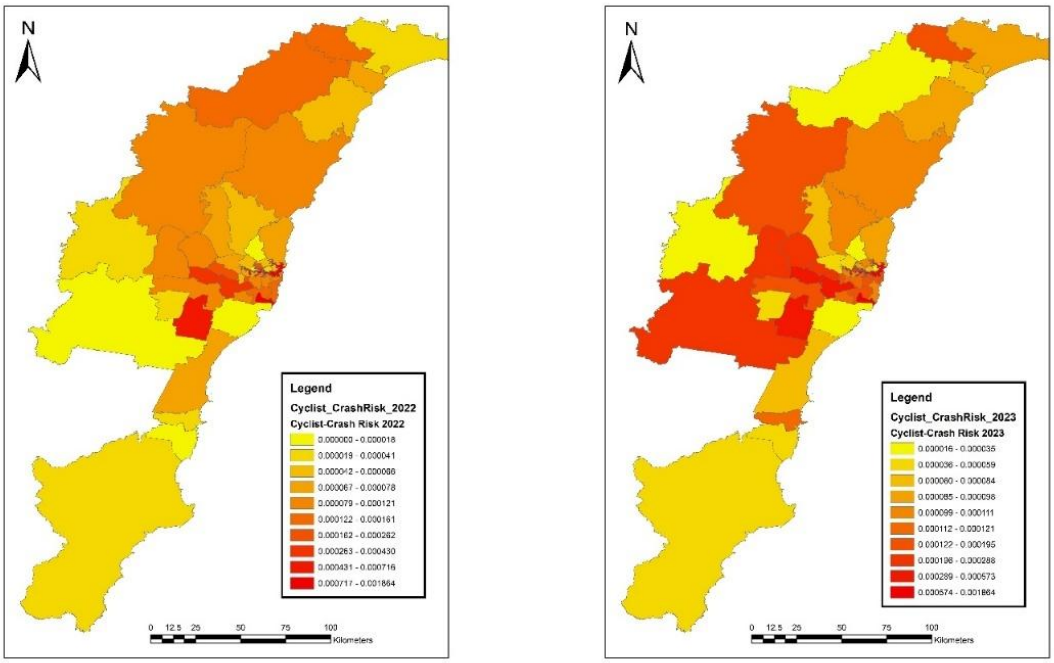
Rank	LGA	2022 Normalised Pedestrian Crash Risk	LGA	2023 Normalised Pedestrian Crash Risk
1	Canterbury-Bankstown	1	Canterbury-Bankstown	1
2	Fairfield	0.95	Fairfield	0.99
3	Mosman	0.79	Cumberland	0.8
4	Cumberland	0.59	Georges River	0.71
5	Liverpool	0.56	Mosman	0.69
6	Penrith	0.52	Canada Bay	0.55
7	Georges River	0.51	Kuring-Gai	0.53
8	Newcastle	0.49	Burwood	0.53
9	Canada Bay	0.44	Newcastle	0.48
10	Cessnock	0.41	Liverpool	0.47

When interpreting the descriptive analysis presented in Section 3.2, it is important to reiterate that the pedestrian crash risk is heightened due to the injury severity profile of pedestrian crashes. Approximately 4.5% of pedestrian crashes resulted in fatalities, and serious injuries accounted for over 40% of all recorded cases. These figures highlight that, although many pedestrian crashes occur in lower-speed environments, their outcomes are often severe, emphasising the vulnerability of pedestrians in vehicle interactions.

3.5.3 Cyclist Risk

Cyclist crash risk was assessed for 2022 and 2023, aligning with the period for which cycling volume estimates were most reliable, like the pedestrian crash risk evaluation. Figure 15 and Table 13 present the LGAs with the greatest cyclist crash risk. Campbelltown, Canterbury-Bankstown, Fairfield and Cumberland recorded the highest risk indices. Unlike the pedestrian crash risk results, several changes were observed in the remaining rankings, with new LGAs entering the top ten in 2023. This is most likely attributed to recent infrastructure upgrades to cycling networks across Greater Sydney, changing the risk profile. As with pedestrian evaluation, the City of Sydney reported high numbers of crashes but a lower risk index once cycling activity was accounted for, resulting in the LGA falling outside of the ten leading LGAs of cycling crash risk. This suggests that while crashes are more frequent in areas with high ridership, the likelihood of a crash for any given cyclist is lower.

The severity profile of cyclist crashes further reinforces the safety concerns associated with this mode. Around 35% of all recorded cyclist crashes in Greater Sydney resulted in serious injuries, a proportion only slightly below that observed for pedestrians. These outcomes underscore the increased vulnerability of cyclists, especially in locations where dedicated or physically separated infrastructure is lacking. A detailed summary of cycling crash risk across all Greater Sydney LGAs is provided in Appendix C.



Plot (a): 2022 *Plot (b): 2023*

Figure 15: Spatial heat maps of cycling crash risk for 2022 and 2023 by LGAs in Greater Sydney

Table 13: Ten leading LGAs according to cycling crash risk for 2022 and 2023

Rank	LGA	2022 Normalised Cyclists Crash Risk	LGA	2023 Normalised Cyclists Crash Risk
1	Campbelltown	1	Campbelltown	1
2	Fairfield	0.6	Canterbury-Bankstown	0.93
3	Canterbury-Bankstown	0.43	Fairfield	0.75
4	Cumberland	0.37	Cumberland	0.5
5	Burwood	0.33	Hunters-Hill	0.43
6	Lane Cove	0.27	Wollondilly	0.42
7	Cessnock	0.22	Penrith	0.41
8	Maitland	0.21	Blacktown	0.4
9	Waverly	0.2	Strathfield	0.34
10	Randwick	0.19	Woollahra	0.32

3.5.4 Correlation Analysis of Active Transport Modes

Correlation analysis further confirmed the strong association between active travel and crash occurrence. Mode-specific crash data were filtered for pedestrians and cyclists, with outcomes including total crashes, fatalities, and injuries of varying severity. To address the small number of fatal cases, particularly for cyclists, fatalities and serious injuries were combined into a single category to strengthen the statistical validity of the results.

Table 14 presents the results of the correlation analysis between trips and aggregated crash data at an LGA aggregation. Strong positive correlations are observed between trip volumes and total crashes for both pedestrians and cyclists, indicating that higher levels of walking or cycling activity are generally associated with a greater number of recorded crashes. For pedestrians, total crashes, moderate injuries, and minor injuries exhibited the strongest associations (*0.7-0.8*), while correlations with serious or fatal outcomes were weaker (*0.5*). This suggests that although more pedestrian activity leads to more incidents overall, crash severity is likely influenced by other factors such as street design and traffic speed. Cycling activity demonstrated even stronger relationships with crash frequency (*0.8* for total crashes) and with moderate or serious injuries (*0.7-0.8*). Fatal crashes, however, showed little correlation with exposure, implying that factors such as helmet use, infrastructure quality, and interactions with motor vehicles play a greater role in determining fatal outcomes.

Table 14: Correlations between walking and cycling trips and categorised crash data

Pedestrian Trips and Crashes						
Year	**Total No. Crashes**	**No. Fatality**	**No. Serious Injuries**	**No. Fatality and Serious Injuries**	**No. Moderate Injuries**	**No. Minor Injuries**
2022	0.73	0.43	0.50	0.51	0.75	0.79
2023	0.71	0.37	0.47	0.48	0.73	0.76
Cyclist Trips and Crashes						
2022	0.84	0.04	0.71	0.71	0.73	0.75
2023	0.81	0.24	0.72	0.72	0.79	0.73

A complementary analysis explored how the extent of walking, cycling, and low-speed (< 40 km/h) road networks related to active-mode crash risk (Table 15). Negative correlations were consistently

observed, with total crash risk for pedestrians and cyclists decreasing as the length of supportive or low-speed infrastructure increased (*-0.15 to -0.33*). This pattern suggests that expanded provision of walkable and cyclable environments (through traffic-calmed streets, shared zones, or dedicated paths) is associated with lower relative crash risk.

Table 15: Correlations between the length of low-speed environment road network and crash risk

Pedestrian Crash Risk and Length of Road Network (< 40km/hr)				
Year	**Total Crash Risk**	**Fatality Crash Risk**	**Serious Injury Crash Risk**	**Moderate Injury Crash Risk**
2022	-0.15	-0.25	-0.27	-0.10
2023	-0.26	0.05	-0.09	0.09
Cycling Crash Risk and Length of Road Network (< 40km/hr)				
2022	-0.33	0.06	-0.31	-0.36
2023	-0.32	-0.12	-0.32	-0.27

Overall, the findings indicate that while greater activity levels naturally correspond to more recorded incidents, **the presence of well-designed, speed-managed infrastructure mitigates risk and enhances safety outcomes for vulnerable road users**. These correlations provide an initial indication of association; further research using multivariate or causal inference methods is recommended to confirm these relationships and quantify their strength.

3.6 Summary of Outcomes

The macroscopic data platform developed through this project has demonstrated the practical value of combining multiple safety datasets (crashes, near-misses, and vehicle speeds) within a unified framework. This integration allows safety performance to be assessed both retrospectively, through historic crash patterns, and proactively, through indicators such as speed behaviour and near-miss frequency. The analysis provides a comprehensive picture of safety conditions across the network and highlights several recurring spatial and behavioural patterns that can guide future design and policy interventions. Key insights across the section can be summarised as follows:

- **Integrated analytical capability**: The combined data platform (crash, speed and near misses) enables holistic assessment of risk, bridging the traditional gap between reactive crash analysis and proactive safety diagnostics.
- **Speed and severity relationship**: Crashes are most frequent in environments with posted speed limits between 40 and 50 km/h, while the most severe outcomes (serious injuries and fatalities) occur disproportionately at higher speeds.
- **Performance of shared spaces**: Shared and low-speed environments tend to reduce the likelihood of fatal outcomes; however, they still present a notable risk of injuries to pedestrians and cyclists, emphasising the need for careful design and user separation.
- **Speed compliance challenges**: Compliance is lowest in very low-speed zones (< 40 km/h), indicating that signage alone is insufficient and that physical and perceptual design cues are essential to reinforce driver behaviour.
- **Exposure-adjusted risk variation**: When normalised for walking, cycling, and vehicle activity, certain LGAs exhibit disproportionately high crash risk, revealing that absolute crash counts can overlook underlying inequities in safety exposure.
- **Implications for practice**: The findings reaffirm the critical role of speed management in achieving Vision Zero objectives and demonstrate that posted limits must be supported by appropriate street design and enforcement.
- **Targeted investment priorities**: Exposure-adjusted results provide a practical basis for prioritising investment in high-risk LGAs, ensuring that limited safety funding delivers the greatest benefit where vulnerability and risk intersect.

4 Case Study Evaluation

4.1 Performance Summary of Case Study Sites

This section presents a descriptive assessment of the 12 shared space case study sites identified in Section 2.2. The sites have been grouped by street typology defined by the DORAS manual. Each site profile integrates information on physical design characteristics, observed travel behaviour, and user perceptions from survey responses. This combination of objective and subjective data provides a holistic view of how each street functions in terms of movement, safety, and design suitability. The comparative overview establishes a foundation for cross-site evaluation and guides the subsequent statistical analysis. The key components of each site profile are outlined below:

- **Physical and contextual description**:
  - Overview of key physical features, including surface materials, spatial layout, signage, landscaping, and integration with adjacent land uses.
  - Discussion of how these characteristics relate to the site's intended Movement and Place functions.
- **Traffic and movement assessment**:
  - Presentation of pneumatic tube count data, reporting volumes of motorised vehicles and bicycles alongside operating speeds.
  - Analysis of average and 85th percentile speeds and daily traffic volumes to evaluate whether vehicle behaviour aligns with the operational intent of a shared space.
- **Pedestrian activity analysis**:
  - Quantitative assessment of pedestrian volumes, crossing times, and dwell times.
  - Interpretation of how people move through and occupy the space, providing insight into walkability, informal crossings, and opportunities for lingering or social interaction.
- **Crash history review**:
  - Summary of historical crash records and near miss data mapped at each site, detailing the number, type, and location of incidents involving different user groups.
  - Identification of spatial or behavioural patterns that inform site-specific safety outcomes.
- **Survey-based perceptions**:
  - Reporting of subjective data from face-to-face (intercept) and online surveys.
  - Intercept survey results summarise average ratings for functionality, design suitability, and perceived safety, along with opinions on appropriate speed limits.
  - Likert-scale questions were standardised into numerical references for consistent analysis, as shown in Table 16.
- **Online survey focus**:
  - Examination of similar themes to the intercept survey but with greater emphasis on design priorities related to safety, comfort, and suitability of shared space features.
- **Community perspectives**:
  - Inclusion of open-ended comments summarised at the end of each profile, offering qualitative insights into community perceptions and lived experiences of the spaces.

Table 16: Translation of "Likert Questions" presented in site summaries

Functionality Questions	Suitability Questions	Safety Questions	Numerical Reference
Very easy to perform	Very suitable	Very safe	5
Easy to perform	Suitable	Safe	4
Neither hard nor easy	Neither suitable nor unsuitable	Neither safe nor unsafe	3
Easy to perform	Unsuitable	Unsafe	2
Very easy to perform	Very unsuitable	Very unsafe	1
I don't know	I don't know	I don't know	I don't know

4.1.1 Destination High Streets

4.1.1.1 Albert Street, Freshwater (D1)

Albert Street is a small-scale retail street in a beachside suburb, featuring shared surface treatments, raised thresholds, and landscaping. The street connects local shops, cafés, and residences with nearby coastal attractions and supports both pedestrian activity and local vehicle access. Figure presents site photographs highlighting some of the key features.



Figure 16: Site photographs of Albert Street, Freshwater

Figure 16 presents the site considered for assessment. Albert Street has a natural extension to Lawrence Street until the intersection with Oliver Street, and this serves as the entry to the lower speed environment, containing similar street design to that of Albert Street. Thus, the site is bounded by Oliver Street to the west (Lawrence Street), Kooloora Avenue to the east and Undercliff Road to the south. This consists of 250 metres of Albert Street and 100m of Lawrence Street. Other key site features include:

- **Speed limit of 40km/h.**
- Five marked pedestrian crossings, two of which are located to at the intersection of Moore Road and Albert Street and the intersection of Albert Street and Lawrence Street. The remaining crossing points are midblock crossing treatments.
- Kerb extensions and footpath widening is present between Moore Street and Dowling Street, with the focal activity area being close to the intersection of Albert Street and Lawrence Street.
- Outdoor dining areas, street furniture and landscaping are present across the corridor.
- The southern leg of Albert Street contains angle parking with considerably narrower footpaths as the infrastructure transitions to standard residential local streets and roads.



Figure 17: Site map of Albert Street, Freshwater extension to Lawrence Street.

Table 17: Summary table of pneumatic tube data at Albert Street, Freshwater (bi-direction statistics)

Location		Lawrence Street (West of Albert Street)	Albert Street (South of Moore Lane)	Albert Street (Between Moore Road and Moore Lane)	Albert Street (Between Moore Road and Kooloora Avenue)	Moore Road (South of Albert Street)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	9,888	1,353	9,385	6,299	2,885
	7-Day Average (vehicles/day)	10,027	1,334	9,775	6,483	2884
	AM Peak (vehicles/hr)	682	108	644	458	204
	PM Peak (vehicles/hr)	333	72	448	295	144
	Max Peak (vehicles/hr)	872	148	828	627	312
Average Daily Cycling Volumes		222	60	232	183	89
Proportion of Heavy Vehicles (%)		2.6	2.3	4.2	2.1	3.1
Proportion of Cyclists + Motorcyclists (%)		2.3	4.3	2.5	2.9	2.9
Motorised Vehicle Speed	*85^{th} Percentile*	26.2	23.1	25.7	37.3	26.6
	Average	20.8	17.8	20.3	30.5	21.0
Bicycle Speed	*85^{th} Percentile*	25.5	24.0	24.7	22.1	25.4
	Average	19.0	18.1	16.7	16.6	18.4

Table 17 summarises the movement statistics of vehicles and bicycles within the study area. Average daily traffic volumes along the main section of the site, Lawrence Street and Albert Street (traversing east-west) are in the range of 6,000 vehicles per day to 10,500, with peak demands occurring during weekends. This is consistent with the DORAS Destination High Street definition where there is a balance of movement and place attributes. Though the posted speed limit is 40km/h, the 85th percentile and average speeds are all below 27km/h, outside of eastern section of Albert Street that is an entry/exit to the denser “place-oriented” sections of the study area. Even in this section, speeds remained below the 40 km/h limit; however, the 85th percentile speeds were only about 10% lower. Notably, cycling speeds closely match those of motor vehicles, indicating a street environment that supports harmonious coexistence between modes without significant conflicts or delays.

Table 18 summarises the pedestrian activity. Pedestrian and crossing volumes are within the range of 90 to 150 peds/hr, reflecting a suburban Destination High Street (CIHT, 2018; NSW Government, 2023a). Consistent with the vehicular movement data gathered from the pneumatic tube counts, there is considerably more walking trips on weekends as compared with weekdays. On weekdays, average dwell times ranged from approximately 100 to 120 seconds, with the longest observed on the south footpath of Albert Street (145 s maximum), suggesting occasional lingering associated with nearby shops and seating areas. Weekend observations show a similar pattern, with slightly higher pedestrian volumes but comparable dwell durations (around 110 s average), implying steady use rather than extended stays. The results suggest that Albert Street functions as an active through-route with short-duration stationary behaviour, typical of streets where walking activity is frequent but not primarily recreational.

Table 18: Summary table of pedestrian behaviour at Albert Street, Freshwater (bi-direction statistics)

Location	Lawrence Street (North footpath)	Lawrence Street (South footpath	Albert Street (South footpath)	Albert Street (North footpath)	Lawrence Street (West midblock crossing)	Lawrence Street (East midblock crossing	Alber Street (South crossing, Moore Lane)	Albert Street (East midblock crossing)	Moore Road (South crossing)
Weekdays									
Average Pedestrian Volumes (peds/hr)	95	90	74	72	68	94	110	141	104
Max Peak (peds/hr)	126	122	88	97	87	118	124	175	132
Average Dwell Time (s)	105	94	117	101					
Maximum Dwell Time (s)	123	102	145	108					
Average Crossing Time (s)					5.15	6	5	7	8
Weekends									
Average Pedestrian Volumes (peds/hr)	128	118	173	167	111	112	191	332	212
Max Peak (peds/hr)	168	167	234	208	176	133	254	439	270
Average Dwell Time (s)	103	103	112	97					
Maximum Dwell Time (s)	112	109	139	101					
Average Crossing Time (s)					5.88	5.99	4.53	6.07	7.51

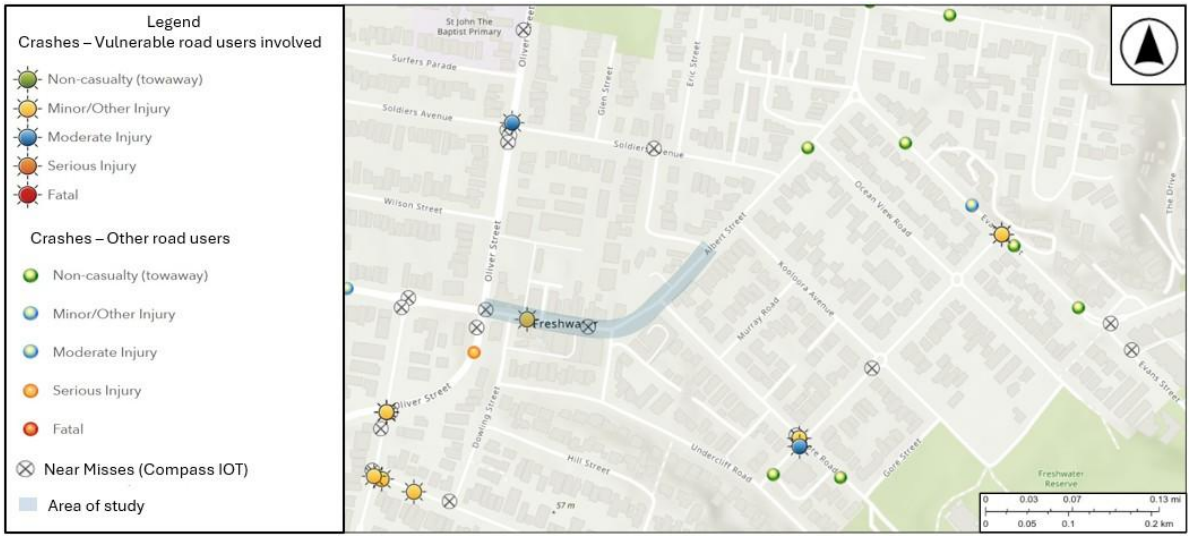


Figure 18: Safety map of Albert Street, Freshwater (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 18 presents the safety map of Albert Street study. There is only one injury crash in the study area but there are eight crashes (four involving vulnerable road users) reported on nearby roads (Oliver Street and Evans Street). This suggests that the specific study area is relatively safe which may be associated with the design implemented. However, there are a series of near misses at the entry point to the study area (intersection with Oliver Street) suggesting there may need to be intersection improvements.

Table 19: Summary of intercept survey results for Albert Street, Freshwater

		5	4	3	2	1	"I don't know"	Total
Sample Size	**62**							
Functionality for Activities (Average Rating)		19.5%	29.7%	16.1%	18.8%	8.2%	7.8%	100%
Suitability of Features (Average Rating)		14.6%	44.0%	10.2%	17.7%	9.8%	3.8%	100%
Suitability for Community		16.1%	54.8%	11.3%	8.1%	9.7%	0.0%	100%
Overall Safety		17.7%	51.6%	12.9%	12.9%	4.8%	0.0%	100%

Table 19 presents the aggregated results of the intercept survey. 62 people participated, with a majority indicating that the study area, on average, is functional across all activities (49.2% rating activities either easy or very easy to perform), has suitable design features (58.6% rating it either suitable or very suitable) and 69.4% believe that the space is safe for the community. Cycling accessibility and infrastructure were the only categories where participants flagged unsuitability (63% of responses).

Table 20: Summary of online survey results for the imagery of Albert Street, Freshwater

		5	4	3	2	1	"I don't know	Total
Sample Size	**128**							
Functionality for Activities (Average Ratings)		28.4%	30.8%	18.8%	14.3%	4.9%	2.9%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (59.4%) Areas for cyclists (bikes and e-bikes) to ride (48.4%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (47.7%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (57.8%) As a Pedestrian: interactions with cyclists (48.4%) As a Cyclist (bikes and e-bikes): interactions with pedestrians (46.9%)							
Word Association (Top 3)	Happy, Beautiful, Quiet							

Table 20 summarises the results of the online survey for respondents that received imagery related to the Albert Street study area. Like the intercept survey results, there was an overall satisfaction of the site in terms of the activities that could be performed (59.2% favourable responses). The online survey confirmed that “areas for cyclists to ride” as a key aspect that most often needs improvement, mirroring the results of the intercept survey. Participants also noted that interactions between vulnerable users (pedestrians and cyclists) and motor vehicles are areas where safety can be improved.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- While participants appreciated the character of Albert Street, it was indicated that revitalisation such as additional vegetation and further amenities including benches, public bathrooms and rubbish bins was needed.
- Safety comments comprised of concerns surrounding pedestrian crossing facilities, potential for lowered speed limits and complaints regarding E-bike usage.

4.1.1.2 Main Street, Blacktown (D2)

Located in the Blacktown town centre, Main Street functions as a key civic and commercial spine. It includes decorative paving, street furniture, gateway elements, and restricted vehicle access, supporting high levels of pedestrian movement and public realm use.



Figure 19: Site photographs of Main Street, Blacktown

Figure 19 illustrates the site that was under consideration for assessment. The intersection of Richmond Road, Kildare Road, and Patrick Street forms the western gateway to the one-way, low-speed section of Main Street near Blacktown Station, while the Campbell Street intersection marks the eastern entry to the commercial precinct. Both ends converge toward Flushcombe Road, which runs through the centre of the study area. The section of interest spans approximately 210 metres between Jim Simpson Lane and Campbell Street and includes several notable site features:

- **Speed limit of 40 km/h.**
- Four signalised crossings: three operating simultaneously at the intersection with Flushcombe Road to create an exclusive pedestrian phase, with one at the intersection with Campbell Street. There are two pedestrian crossings serving as midpoint crossing treatments, with one unmarked crossing facilitating pedestrian access to Yan Willama Road and a nearby car park.
- Footpath widening and fencing are present along the western side of Main Street, allowing for outdoor dining areas, street furniture, and greenery, with similar enhancements along the eastern side in front of the shops.
- The eastern leg of Main Street features angle parking providing access to the adjacent shops.

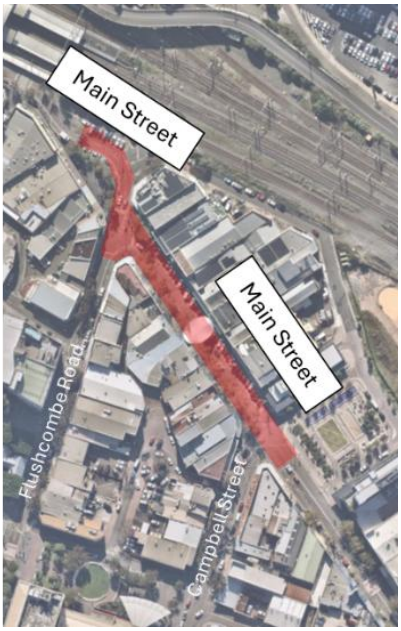


Figure 20: Site map of Main Street, Blacktown

Table 21: Summary table of pneumatic tube data at Main Street, Blacktown (bi-direction statistics)

Location		Main St (East of Flushcombe Road)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	2,566
	7-Day Average (vehicles/day)	2,476
	AM Peak (vehicles/hr)	178
	PM Peak (vehicles/hr)	214
	Max Peak (vehicles/hr)	214
Average Daily Cycling Volumes		29
Proportion of Heavy Vehicles (%)		2.6
Proportion of Cyclists + Motorcyclists (%)		1.3
Motorised Vehicle Speed	*85th Percentile*	20.2
	Average	14.5
Bicycle Speed	*85th Percentile*	21.5
	Average	12.2

Table 21 summarises the movement statistics of vehicles and bicycles within the study area. Average daily traffic volumes along the main section of the site, Main Street (traversing east-west) are in the range of 2,500 vehicles per day, with peak demands occurring during the later days of the week (Wednesday, Thursday, Friday) with weekend demand remaining higher than 2,000. Though the posted speed limit is 40 km/h, the 85th percentile and average speeds were observed below 21 km/h and 15 km/h respectively. Notably, cycling speeds closely match those of motor vehicles, indicating a street environment that supports harmonious coexistence between modes without significant conflicts or delays.

Table 22: Summary table of pedestrian behaviour at Main Street, Blacktown (bi-direction statistics)

Location	Main Street (Northwest footpath)	Main Street (southeast footpath)	Main Street (northeast footpath)	Jim Simpson Lane (crossing)	Main Street (East/west crossing)	Main Street (North/south crossing)
Weekdays						
Average Pedestrian Volumes (peds/hr)	258	136	190	78	376	63
Max Peak (peds/hr)	313	196	272	109	453	97
Average Dwell Time (s)	90	99	94			
Maximum Dwell Time (s)	96	114	97			
Average Crossing Time (s)				4.95	5.13	6.25
Weekends						
Average Pedestrian Volumes (peds/hr)	144	73	120	41	216	39
Max Peak (peds/hr)	202	109	173	63	306	58
Average Dwell Time (s)	89	98	86			
Maximum Dwell Time (s)	98	123	98			
Average Crossing Time (s)				6.08	5.25	5.39

Table 22 summarises the pedestrian activity. Pedestrian and crossing values vary significantly based on location, with volumes between 70-300 peds/hr, reflecting a suburban Destination High Street (NSW Government, 2023a). Consistent with the vehicular movement data gathered from the pneumatic tube

count, there is a greater number of walking trips on weekdays in comparison to weekends. Dwell times are similar in nature to that of Albert Street with dwell values between 90 and 120 seconds.

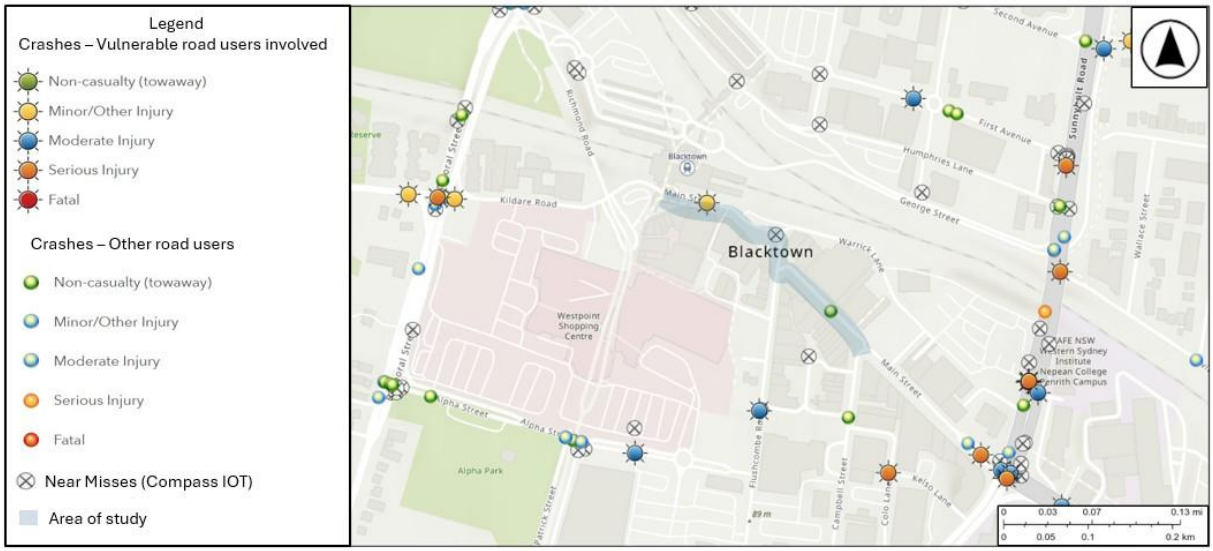


Figure 21: Safety map of Main Street, Blacktown (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 21 presents the historical safety record of the site, showing one near miss and one crashes resulting in minor injuries, over the five years. Although the total number of incidents is low, only recorded crash involved vulnerable road users, fortunately, without serious injuries. In contrast, six crashes were documented on upstream, downstream, and connected links adjacent to the study area, three of which involved vulnerable users. Notably, two of these crashes resulted in serious injuries. This comparison highlights the potential effectiveness of shared zone areas in not only reducing the frequency of crashes but also mitigating their severity, even in environments with high levels of interaction among diverse road users.

Table 23: Summary of intercept survey results for Main Street, Blacktown

		5	4	3	2	1	"I don't know"	Total
Sample Size	**39**							
Functionality for Activities (Average Rating)		8.2%	34.6%	24.2%	17.9%	8.2%	6.9%	100%
Suitability of Features (Average Rating)		7.8%	42.6%	13.8%	19.7%	10.1%	6.0%	100%
Suitability for Community		2.6%	51.3%	17.9%	12.8%	12.8%	2.6%	100%
Overall Safety		2.6%	38.5%	20.5%	23.1%	15.4%	0.0%	100%

Table 23 presents the consolidated results of the intercept survey. 39 people participated with a majority indicating the study area, on average, is functional for activities (42.8% rating activities either easy or very easy to perform), has suitable design features (50.4% rating it either suitable or very suitable) and 53.9% believe that the space is suitable for the community. There is a relatively equal split between respondents on whether the street is safe, with 41.1% believe that the street is safe and 38.5% stating the street is unsafe. Participants also indicate that the street is hard for children to play (65% of responses rating hard to perform or very hard to perform). Cycling accessibility and infrastructure are also flagged unsuitable by respondents (46% of responses rating it either suitable or very suitable).

Table 24: Summary of online survey results for the imagery of Main Street, Blacktown

		5	4	3	2	1	"I don't know	Total
Sample Size	**153**							
Functionality for Activities (Average Ratings)		23.0%	38.1%	17.6%	14.1%	3.9%	3.3%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (53.6%) Areas for cyclists (bikes and e-bikes) to ride (51.0%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (47.7%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (63.4%) As a Pedestrian: interactions with cyclists (62.1%) As a Cyclist (bikes and e-bikes): interactions with pedestrians (52.9%)							
Word Association (Top 3)	Happy, Beautiful, Quiet							

Table 24 summarises the results of the online survey for respondents that received photo imagery related to the Main Street study area. The results of the online survey results are close to the intercept survey, with an overall satisfaction to the functionality for activities (61.1% favourable responses). The online survey confirms that “areas for cyclist to ride” as a key aspect for improvement, which mirrors the intercept survey. Participants also flag their concerns over the interactions between vulnerable users (pedestrians and cyclists) and motor vehicles, which safety can be improved.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Concerns regarding security and safety at night as a result anti-social and criminal behaviour, with the potential to implement additional street lighting and improved visibility as a deterrent.
- Revitalisation including an expanded communal area, additional bike lanes and pedestrian crossings improving overall safety, and added amenities (e.g. bins and public bathrooms).
- Contradicting the above, comments also indicated a desire to remove public benches to reduce anti-social behaviour.

4.1.1.3 Bankstown City Plaza, Bankstown (D3)

Bankstown City Plaza is a centrally located pedestrian mall with integrated landscaping, public seating, decorative paving, and occasional service vehicle access. It is a key retail and community gathering space, hosting events and markets within the Bankstown CBD.



Figure 22: Site photographs of Bankstown City Plaza, Blacktown

Figure 22 describes the site area designated for assessment. The road features one-way traffic flowing into Dale Parade. The location is bound by two raised pedestrian crossings at each entry point to Bankstown City Plaza as shown on the site map (Figure 23). Vehicles must give way to traffic flowing from Chapel Road to Dale Parade at the western edge of the site. The site is 130m in length and offers informal pedestrian crossing opportunities along the length. Other key street features include:

- **Defined shared zone with speed limit of 10 km/h**
- Road narrowing to (3.0 - 3.5m width) using fencing, hedges and kerb blisters along the road encourage a low-speed road environment.
- Parallel parking along both sides of Bankstown city plaza further contribute to the road narrowing whilst also providing access to the local shops.
- Wide footpaths (6.0 - 6.5m) provide area for street furniture, shop displays and street vendors at the centre of the site near the intersection with Dale Parade.

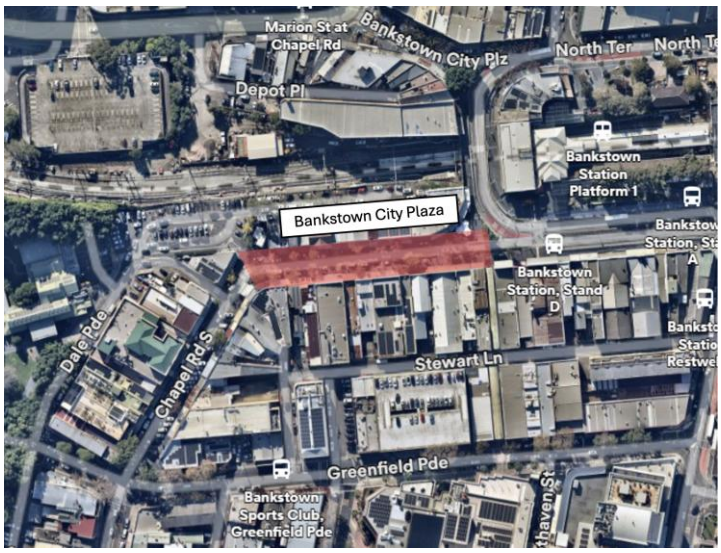


Figure 23: Site Map of Bankstown City Plaza, Bankstown

Table 25: Summary table of pneumatic tube data at Bankstown City Plaza, Bankstown (bi-direction statistics)

Location		Bankstown City Plaza (Midblock of Study Area)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	1,312
	7-Day Average (vehicles/day)	1,353
	AM Peak (vehicles/hr)	84
	PM Peak (vehicles/hr)	99
	Max Peak (vehicles/hr)	117
Average Daily Cycling Volumes		47
Proportion of Heavy Vehicles (%)		5.8
Proportion of Cyclists + Motorcyclists (%)		3.5
Motorised Vehicle Speed	*85th Percentile*	20.6
	Average	14.5
Bicycle Speed	*85th Percentile*	22.5
	Average	13.0

Table 25 summarises the movement statistics of vehicles and bicycles within the study area. Average daily traffic volumes along the main section of the site, Bankstown City Plaza (traversing east-west) was observed to be around 1,300 vehicles per day, with peak demands occurring during the weekends. This is consistent with the DORAS Destination High Street definition, with the street's focus on pedestrian usage, leisure, retail and cultural activities. While the posted speed limit is 10 km/h, the 85th percentile and average speeds recorded highlight a lack of compliance with values exceeding the limit by 5 to 10 km/h. Interestingly, cycling speeds were observed to be similar, with the 85th percentile recording higher speeds still. This indicates that the street environment supports harmonious coexistence between modes without significant conflicts or delays.

Table 26: Summary table of pedestrian behaviour at Bankstown City Plaza, Bankstown (bi-direction statistics)

Location	Bankstown City Plaza (North of Chapel Road)	Bankstown City Plaza (North footpath)	Bankstown City Plaza (South footpath)	Bankstown City Plaza (East wombat crossing)	Bankstown City Plaza (West wombat crossing)	Bankstown City Plaza (signalised crossing)
Weekdays						
Average Pedestrian Volumes (peds/hr)	160	376	427	304	457	594
Max Peak (peds/hr)	241	492	545	418	558	773
Average Dwell Time (s)	58	41	84			
Maximum Dwell Time (s)	60	44	87			
Average Crossing Time (s)				4.68	3.54	7.51
Weekends						
Average Pedestrian Volumes (peds/hr)	275	566	651	562	599	457
Max Peak (peds/hr)	342	861	1019	776	965	628
Average Dwell Time (s)	57	40	85			
Maximum Dwell Time (s)	61	42	97			
Average Crossing Time (s)				4.16	5.04	8.23

Table 26 summarises the pedestrian activity for Bankstown City Plaza documented at multiple points across the study area. Unlike the other 2 locations, there are far greater average dwell time ranges

between 160 and 650 seconds and pedestrian volumes, and this is most likely associated with the greater presence of grocery stores and commercial properties (not just restaurants and offices). This example is more reflective of a Destination High Street, attracting the local community to complete activities within its vicinity.

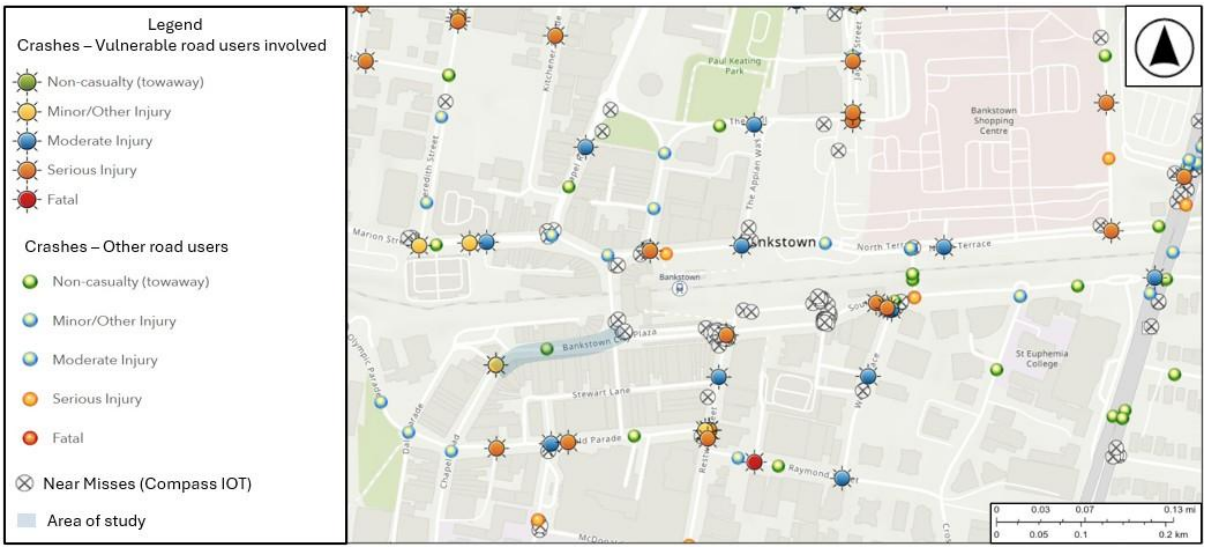


Figure 24: Safety map of Bankstown City Plaza, Bankstown (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 24 presents the historical safety record for the site, showing six near misses and two recorded crashes, including one involving a vulnerable road user. The number of crashes within the study area is notably lower than adjacent links, which collectively recorded 13 crashes, 10 involving vulnerable users and five resulting in serious injuries. This comparison highlights the site's strong relative safety performance, particularly in managing risks where multiple transport modes interact.

Table 27: Summary of intercept survey results for Bankstown City Plaza, Bankstown

		5	4	3	2	1	"I don't know"	Total
Sample Size	**40**							
Functionality for Activities (Average Rating)		18.6%	28.1%	16.7%	14.7%	15.5%	6.4%	100%
Suitability of Features (Average Rating)		15.8%	38.5%	13.6%	17.2%	12.1%	2.8%	100%
Suitability for Community		10.0%	55.0%	17.5%	10.0%	7.5%	0.0%	100%
Overall Safety		10.0%	57.5%	22.5%	5.0%	5.0%	0.0%	100%

Table 27 summarises the results of the intercept survey for Bankstown City Plaza, completed by 40 participants. Most respondents considered the area functional for activities (46.7%) and well designed (54.3%), with higher agreement that the street is suitable for the community (65%) and safe (67.5%). However, cycling infrastructure (63%) and parking accessibility (60%) were frequently rated as unsuitable, and more than half of respondents (53%) expressed concerns about street cleanliness.

Table 28: Summary of online survey results for the imagery of Bankstown City Plaza, Bankstown

		5	4	3	2	1	"I don't know	Total
Sample Size	**142**							
Functionality for Activities (Average Ratings)		25.4%	29.0%	18.1%	17.7%	7.5%	2.2%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (62.0%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (49.3%) Areas for cyclists (bikes and e-bikes) to ride (40.1%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (69.7%) As a Pedestrian: interactions with cyclists (53.5%) As a Pedestrian: interactions with motorcyclists (52.8%)							
Word Association (Top 3)	Happy, Beautiful, Noisy							

Table 28 presents the summarised results of the online survey for Bankstown City Plaza, where respondents evaluated images of the study area. The findings closely align with those from the intercept survey, with participants reporting a 54.4% favourable rating for the site's overall functionality and suitability for everyday activities. The online responses also emphasised the need to prioritise provision for cyclists, identifying the lack of dedicated riding areas as a key opportunity for improvement. Participants further expressed concerns about safety at points of interaction between pedestrians, motor vehicles, and cyclists, highlighting the importance of design measures that strengthen user separation and improve visibility.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Participants praised the space for its strong community atmosphere and cultural diversity
- Suggestions for improvements of communal spaces (including those for children), bike lanes to generated better connectivity between neighbouring suburbs
- Concerns surrounding cleanliness were raised, including café and restaurant patrons smoking, littering and wastewater pollution/odours.

4.1.2 Residential Lanes/Ways, Neighbourhood Streets, Yield Streets

4.1.2.1 Chisholm Street / Sims Street / Hannam Street / Flemings Lane, Darlinghurst (R1)

This laneway network lies within a dense inner-city neighbourhood. The area includes level paving, minimal kerb definition, restricted vehicle access, and shared use zones. These laneways provide access to housing, local services, and informal pedestrian movement.



Figure 25: Site photographs of Chisholm Street, Darlinghurst

Figure 25 illustrates the area designated for assessment. Chisholm Street, Sims Street, Hannam Street and Flemings Lane form a small community of streets forming a low-speed residential environment. They are bounded by the surrounding streets Taylor Street, South Dowling Street and Flinders Street, serving as a pedestrian thoroughfare through to nearby shops and cafes. Other key street features include:

- **Defined shared zone 10 km/h speed limit.**
- Fully cobbled streets help to create a shared environment by visually and physically blurring the distinction between pedestrian and vehicle space, promoting slower speeds and more considerate interactions between users.
- Pavement consistency between footpaths and road surfaces fosters sharing.
- Parallel parking along the streets provided residential parking for the surrounding houses.
- Small square at the intersection between Chisholm Street and Hannam Street provides area for socialisation and community events.



Figure 26: Site Map of Chisholm Street, Sims Street, Hannam Street and Flemings Lane

Table 29: Summary table of pneumatic tube data at Chisholm Street (bi-direction statistics)

Location		Chisholm St (Outside Property 46)	Sims St (Outside Property 16)	Hannam St (Outside Property 4)	Flemings Ln (South of Hannam St)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	122	23	328	46
	7-Day Average (vehicles/day)	110	25	328	38
	AM Peak (vehicles/hr)	9	4	31	5
	PM Peak (vehicles/hr)	0	0	42	7
	Max Peak (vehicles/hr)	19	8	46	11
Average Daily Cycling Volumes		14	12	73	24
Proportion of Heavy Vehicles (%)		0.8	0.0	7.6	0.0
Proportion of Cyclists + Motorcyclists (%)		8.3	28.6	23.2	60.5
Motorised Vehicle Speed	*85^{th} Percentile*	14.7	17.1	18.6	16.4
	Average	11.8	13.1	14	12.0
Bicycle Speed	*85^{th} Percentile*	15.8	18.7	21.1	20.2
	Average	12.7	15.5	16.2	16.7

Table 29 summarises the movement statistics of vehicles and bicycles within the study area. Outside of Hannam Street, all other streets have daily traffic volumes of less than 150 vehicles/day, a reflection of a set of quiet Residential Ways or Lanes. Hannam Street has higher daily traffic values averaging above 300 vehicles/day as it provides direct access to the main road (Flinders Street) to the west of the site. Like the performance of Bankstown City Plaza, the observed speeds were considerably greater than the posted speed limit of 10 km/h of both vehicles and bicycles. Given the residential context, heavy vehicle percentages were also low, outside of Hannam Street which serves as an access way for service vehicles.

Table 30: Summary table of pedestrian behaviour at Darlinghurst shared space streets (bi-direction statistics)

Location	Chisholm Street (footpath)	Chisholm Street (South of Taylor Street)	Chisholm Street (South of Sims Street)	Chisholm Street (North of Hannam Street)	Sims Street (North of Hannam Street)	Flemming Lane (South of Hannam Street)	Hannam Street (East of Chisholm Street)
Weekdays							
Average Pedestrian Volumes (peds/hr)	0	18	0	4	8	1	4
Max Peak (peds/hr)	0	25	2	6	16	4	9
Average Dwell Time (s)	0						
Maximum Dwell Time (s)	0						
Average Crossing Time (s)		6.81	7.00	6.03	4.53	4.67	5.25
Weekends							
Average Pedestrian Volumes (peds/hr)	0	18	2	6	6	2	3
Max Peak (peds/hr)	2	23	4	14	17	7	6
Average Dwell Time (s)	2						
Maximum Dwell Time (s)	9						
Average Crossing Time (s)		7.50	13.57	5.52	5.60	3.80	5.41

Table 30 summarises pedestrian activity along Chisholm Street and adjoining links, showing very low volumes (less 30 pedestrians/hr) and minimal dwell behaviour, with most movements short and direct.

This pattern aligns with the DORAS typology of Residential Ways and Lanes, which are designed as low-movement environments primarily serving local access (NSW Government, 2023a).

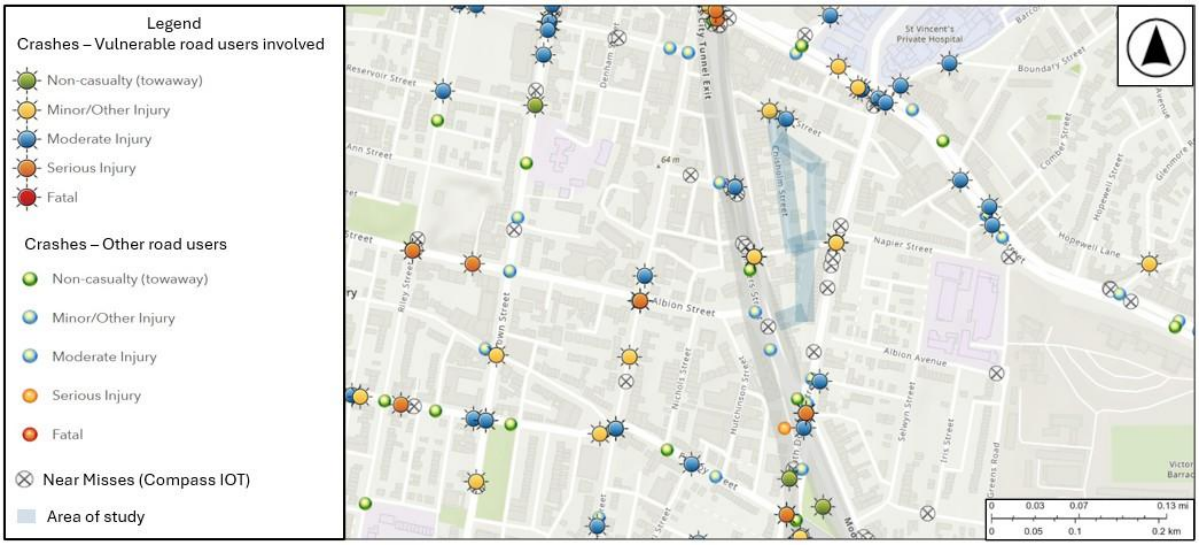


Figure 27: Safety map of Chisholm Street, Darlinghurst (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

The safety map (Figure 27) illustrates the site's historical safety performance, revealing a notably low incident rate, with no near misses and only a single recorded crash. While that crash did involve a vulnerable road user, it fortunately did not result in serious injury. In comparison, adjacent streets have experienced a substantially higher number of crashes, many of which involved vulnerable road users and led to serious injuries. This contrast underscores the relative safety of the study site and suggests that its design may play a role in mitigating risk and enhancing safety outcomes for all road users.

Table 31: Summary of intercept survey results for Chisholm Street, Darlinghurst

		5	4	3	2	1	"I don't know"	Total
Sample Size	**47**							
Functionality for Activities (Average Rating)		15.0%	20.6%	23.0%	19.7%	12.9%	8.8%	100%
Suitability of Features (Average Rating)		14.9%	34.3%	15.4%	20.7%	11.7%	3.1%	100%
Suitability for Community		14.9%	46.8%	14.9%	10.6%	10.6%	2.1%	100%
Overall Safety		6.4%	44.7%	23.4%	14.9%	8.5%	2.1%	100%

Table 31 presents the aggregated results of the intercept survey. A total of 47 people participated in the survey, with most respondents rating the study area as having suitable street features (49.2% rating it suitable or very suitable), is suitable for the community (61.7% rating it suitable or very suitable), and an overall satisfaction on perception of safety (51.1% rating it safe or very safe). Survey responses indicate mixed perceptions of functionality within the study area. Only about one-third of participants (35.6%) found activities easy to perform, while a similar proportion (32.6%) reported difficulty. Activities such as exercise and those involving children or people with disability were most frequently rated as hard to perform. Participants also identified shortcomings in public transport access, cycling and parking infrastructure, and street cleanliness. These limitations in activities are most likely associated with the road network context as the site is wedged between two main arterial roads, Flinders Street and South Dowling Street.

Table 32: Summary of online survey results for the imagery of Chisholm Street, Darlinghurst

		5	4	3	2	1	"I don't know	Total
Sample Size	**145**							
Functionality for Activities (Average Ratings)		25.0%	24.2%	17.1%	19.3%	12.2%	2.3%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (48.3%) Areas for pedestrians to walk or dwell (38.6%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (37.9%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (69.7%) As a Pedestrian: interactions with motorcyclists (46.9%) As a Pedestrian: interactions with cyclists (44.8%)							
Word Association (Top 3)	Happy, Ugly, Quiet							

Table 32 summarises the online survey results for Chisholm Street, Darlinghurst, where respondents assessed images of the site. Compared with the intercept survey, a larger share of participants (49.2%) considered the area functional for activities. This difference may have occurred as participants were not provided geographic context which was considered by respondents of the intercept survey. However, both surveys identified similar priorities for improvement, particularly enhancing pedestrian spaces, public transport accessibility, and safety at points of interaction between pedestrians and other transport modes.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Participants noted issues such as narrow carriageways, limited parking, and vehicle speeding, with some reporting that drivers use the street as a shortcut between major roads. The speeding and road use is reflected in the objective data collected.
- Respondents identified safety risks associated with cyclists and e-bike users exceeding speed limits and causing near-miss incidents with pedestrians.
- Common suggestions included enhanced public transport access, clearer speed signage, more regular maintenance, and additional street amenities such as benches, rubbish bins, and improved accessibility for people with disabilities.
- Many respondents specifically requested new or improved crossings at South Dowling Street to enhance pedestrian safety and connectivity.

4.1.2.2 Meehan Street, Granville (R2)

Meehan Street is a local residential street located within a high-density housing area of Granville. The street primarily serves local access and short walking trips, connecting nearby residential blocks with surrounding collector roads. It features narrow carriageways, on-street parking, and continuous footpaths on both sides, with verge landscaping providing some visual enclosure.



Figure 28**: Site photographs of Meehan Street, Granville**

Figure 28 depicts the area designated for assessment. The extent of Meehan Street considered for assessment is defined by Railway Street, marking the western boundary and extends to just before Church Street on the eastern side, shy of the transition from residential to industrial land use. Additionally, the street includes several intersecting roads that share similar characteristics. The residential section of Meehan Street spans a total of 570 meters, constituting the area under consideration.

- **Speed limit of 50 km/h.**
- Wallawa Reserve, situated at Meehan Street's (opposite Inkerman Street), provides a green space with furniture and a playground, facilitating social/community interaction.
- Standard residential street with footpaths, kerbs and gutters and street parking along the street's length.
- No signalised or marked crossings promoting informal crossing



Figure 29 Site Map Meehan Street, Granville

Table 33: Summary table of pneumatic tube data at Meehan Street, Granville (bi-direction statistics)

Location		Meehan St (East of Inkerman St)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	2,021
	7-Day Average (vehicles/day)	1,916
	AM Peak (vehicles/hr)	140
	PM Peak (vehicles/hr)	148
	Max Peak (vehicles/hr)	215
Average Daily Cycling Volumes		36
Proportion of Heavy Vehicles (%)		2.5
Proportion of Cyclists + Motorcyclists (%)		1.8
Motorised Vehicle Speed	*85th Percentile*	44.2
	Average	36.6
Bicycle Speed	*85th Percentile*	29.2
	Average	20.4

Table 33 summarises the vehicle and bicycle movement characteristics along Meehan Street (east of Inkerman Street). Average daily traffic volumes were approximately 2,000 vehicles per day, with modest weekday peaks reaching around 215 vehicles per hour. These volumes align with the DORAS typology of a Neighbourhood Street, which is intended to prioritise local access and low through movement. The posted speed limit of 50 km/h was generally well observed, with 85th percentile speeds of 44 km/h and an average of 37 km/h. Cycling activity was limited, averaging 36 cyclists per day, although observed cycling speeds were relatively high (average 20 km/h; 85th percentile 29 km/h), suggesting minimal interaction delays and a generally free-flowing environment.

Table 34: Summary table of pedestrian behaviour at Meehan Street, Granville (bi-direction statistics)

Location	Meehan Street (North footpath)	Meehan Street (South footpath)	Meehan Street (Crossing – Inkerman Street to Wallawa Reserve)
Weekdays			
Average Pedestrian Volumes (peds/hr)	21	24	3
Max Peak (peds/hr)	26	45	6
Average Dwell Time (s)	83	84	
Maximum Dwell Time (s)	104	104	
Average Crossing Time (s)			9.47
Weekends			
Average Pedestrian Volumes (peds/hr)	10	10	2
Max Peak (peds/hr)	21	18	4
Average Dwell Time (s)	46	45	
Maximum Dwell Time (s)	78	64	
Average Crossing Time (s)			0.74

Table 34 summarises the pedestrian activity. Pedestrian activity along Meehan Street was relatively low, reflecting its local residential function. On weekdays, average pedestrian volumes ranged from 21 to 24 pedestrians per hour along the footpaths, with occasional peaks up to 45 pedestrians per hour on the south side. Weekend activity declined to around 10 pedestrians per hour, with shorter dwell times observed. Crossing activity near Inkerman Street and Wallawa Reserve was minimal.

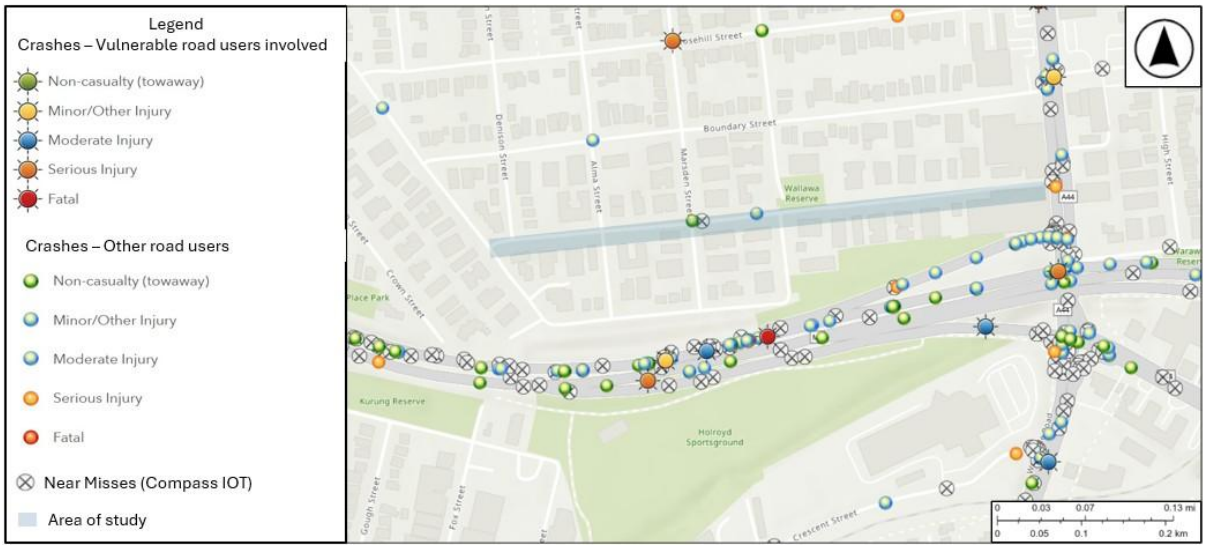


Figure 30: Safety map of Meehan Street, Granville (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

The safety map (Figure 30) presents the historical safety record of Meehan Street, documenting four near misses and five crashes. Fortunately, none of these crashes resulted in serious injuries, and no vulnerable road users were involved. In contrast, nearby streets show a considerably higher number of crashes, with a significant proportion involving vulnerable road users and resulting in serious injuries. This disparity highlights the relative safety of the study site and suggests that its design may contribute to reduced risk and improved outcomes for all road users

Table 35: Summary of intercept survey results for Meehan Street, Granville

		5	4	3	2	1	"I don't know"	Total
Sample Size	**25**							
Functionality for Activities (Average Rating)		16.0%	30.0%	18.5%	22.3%	11.8%	1.5%	100%
Suitability of Features (Average Rating)		6.9%	33.6%	11.1%	24.2%	20.9%	3.3%	100%
Suitability for Community		0.0%	36.0%	12.0%	24.0%	28.0%	0.0%	100%
Overall Safety		0.0%	28.0%	36.0%	20.0%	16.0%	0.0%	100%

Table 35 summarises the aggregate results of the intercept survey for Meehan Street, Granville, based on responses from 25 participants. Overall, 46% of respondents considered the street functional for everyday activities, although exercise (48%) and cycling (52%) were commonly rated as difficult to perform. Perceptions of design suitability were divided, with 40.5% describing street features as suitable and 45.1% as unsuitable. More than half of participants (52%) also felt the street was unsuitable for the community, highlighting concerns with public transport access, cycling infrastructure, and parking. Perceptions of safety were mixed, with only 28% of respondents feeling safe, while equal proportions (36% each) felt unsafe or neutral.

Table 36: Summary of online survey results for the imagery of Meehan Street, Granville

		5	4	3	2	1	"I don't know	Total
Sample Size	**132**							
Functionality for Activities (Average Ratings)		35.5%	35.9%	13.7%	7.1%	4.0%	3.7%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (61.4%) Areas for cyclists (bikes and e-bikes) to ride (48.5%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (47.7%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (56.8%) As a Pedestrian: interactions with cyclists (55.3%) As a Cyclist (bikes and e-bikes): interactions with pedestrians (43.2%)							
Word Association (Top 3)	Happy, Beautiful, Quiet							

Table 36 presents the results of the online survey where participants evaluated images of the study area. In contrast to the intercept survey, online respondents generally viewed the street as functional for most activities, with 71.4% rating them as easy or very easy to perform. However, both surveys showed consistency in identifying priority areas for improvement, particularly provision for cyclists and public transport accessibility. Participants also emphasised safety concerns related to interactions between vulnerable users and motor vehicles.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- The online survey praised the street as beautiful and quiet, whereas the intercept survey raised concerns surrounding design, safety and accessibility.
- Intercept survey comments suggested improvements to accessibility through parking infrastructure, removal of time restrictions for residents and dedicated bus services along the street.
- Recommendations for enhancements to the local park, including the addition of water fountains, fences and public benches.
- Participants raised concerns regarding cleanliness of the street indicating it could benefit from regular cleaning and improved vegetation maintenance.
- Safety concerns consisted of reports surrounding illegal activities and disorderly behaviours advocating for security cameras and better street lighting as deterrents.
- Respondents suggested traffic calming measures such as speed humps/cushions and improved speed limit signage, alongside additional pedestrian crossings.

4.1.2.3 Private Street, Greater Sydney (R3)

As noted in Section 2.2, a private street was included as one of the case study locations. **In order to maintain confidentiality and privacy, the following summary does not provide details of the geographic location**. However, the functionality and community feedback regarding the site is summarised below. The Private Street is a residential street within a master-planned development. It features narrow carriageways, informal pedestrian access, planted verges, and no formal kerbs or footpaths, facilitating low-speed, mixed-use movement in a suburban residential setting.

Key street features include:

- **Speed limit of 10 km/h.**
- Local street environment featuring footpaths on both sides and landscaped verges, supporting community activity and social interaction within the street.
- Decorative paving and greenery at all intersections, promotes shared behaviours and encourages reduced vehicle speeds.
- Signage indicating the presence of unmarked cyclist and pedestrian crossings foster a shared environment through the extent of the road.

Surrounding streets consist of similar features and treatments.

Peak traffic demands occurring on the street vary between 100 to 150 vehicles per day, consistent with the expectations of a Neighbourhood Street / Residential Way definition of streets with low traffic volumes Although the posted speed limit is 10 km/h (shared zone), observed 85th percentile and average speeds exceeded 22 km/h, similar to the performance of the other shared zone case studies. Cycling speeds were comparable to those of motor vehicles, suggesting a shared environment with fluid movement and minimal conflict between travel modes.

Pedestrian activity is very low, with peak movements being 4 pedestrians per hour, this aligns with a quiet residential street used with low community activity. The study area is also safe with no recorded crashes (2019 to 2023) or near misses (2022 to 2023).

Results of the intercept survey underline that a majority of people, on average, find that Private Street is functional for all activities (71.6% rating activities either easy or very easy to perform), has suitable street features (75.7% rating it either suitable or very suitable), 82.4% rating the street suitable for the community, and 87.5% of participants rating the street to be safe. Public transport is the only category where opinions are evenly split, with half of the respondents finding it suitable and the other half finding it unsuitable.

The findings of the online survey are consistent with those of the intercept survey. Participants are satisfied with the functionality for activities for the study area (70.6% rating it easy or very easy to perform). The online survey also confirms that public transport accessibility as a key aspect for future street improvements. Participants also raise concerns about interactions between vulnerable users (pedestrian and cyclists) and motor vehicles, highlighting a need to enhance safety.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Participants praised the space as a beautiful and quiet place.
- Primary concerns were centred around E-bike usage, with comments regarding the implementation of cycling infrastructure such as bike lanes for improved pedestrian and cyclist safety.
- Suggestions were made about enhancement of the street such as shade over benches. Improved speed limit signage and more frequent bus services.

4.1.3 Connector Streets

4.1.3.1 North Steyne and South Steyne, Manly (C1)

North and South Steyne (N Steyne and S Steyne) are coastal connector street corridor serving high levels of pedestrian activity and linking the beachfront to the Manly town centre. Shared space treatments include raised pedestrian crossings, landscaped medians, and design features that accommodate active transport and local traffic.



Figure 31: Site photographs of N Steyne and S Steyne, Manly

The intersection of S Steyne and N Steyne, along with the pedestrian thoroughfare, The Corso, constitutes the civic centre of the Manly Beachfront. As shown in the site photographs of Figure 31, the area under investigation is bordered by the pedestrian crossing near Raglan Street to the north and the crossing near Wentworth Street to the south. This stretches 270 meters, extending from the western footpath to the eastern edge, meeting the beach. Figure 32 depicts the designated site area for assessment. Notable features of the area include:

- **High pedestrian activity area with a consistent 30 km/h speed limit across Manly.**
- Shared pedestrian–cyclist path along the beachfront, complemented by a decorative pedestrian-only promenade lined with greenery.
- Multiple pedestrian crossings, including a wide signalised crossing at The Corso, enhancing walkability.
- Grassed areas adjacent to footpaths providing recreational open space.
- Ample street furniture and bicycle racks encouraging public use and cycling. Well-distributed lighting ensuring a safe and welcoming night-time environment.



Figure 32: Site Map of South Steyne and North Steyne

Table 37: Summary table of pneumatic tube data at N Steyne and S Steyne, Manly (bi-direction statistics)

Location		N Steyne (North of The Corso)	S Steyne (South of The Corso)	Wentworth St (East of S Steyne)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	9,294	8,272	3,865
	7-Day Average (vehicles/day)	9,319	8,490	3,931
	AM Peak (vehicles/hr)	702	660	333
	PM Peak (vehicles/hr)	438	425	149
	Max Peak (vehicles/hr)	817	703	401
Average Daily Cycling Volumes		375	296	260
Proportion of Heavy Vehicles (%)		2.5	2.9	4.3
Proportion of Cyclists + Motorcyclists (%)		4.4	3.9	6.8
Motorised Vehicle Speed	*85th Percentile*	27.2	28.0	23.6
	Average	21.8	22.5	18.5
Bicycle Speed	*85th Percentile*	27.6	28.5	22.5
	Average	21.8	22.8	16.4

Table 37 summarises the vehicle and bicycle movement characteristics within the N Steyne, S Steyne, and Wentworth Street corridor. Average daily traffic volumes range from 6,500 to 9,500 vehicles per day, with peak activity occurring on weekends, reflecting the area's strong recreational and leisure function. These patterns are consistent with the DORAS typology of *Connector Streets*, which are designed to balance movement with vibrant place-based activity in coastal or mixed-use environments (NSW Government, 2023a). Despite a posted speed limit of 30 km/h, observed 85th percentile and average speeds remained below 28 km/h, indicating strong compliance. Cycling speeds were comparable to motor vehicle speeds, suggesting a shared street environment that accommodates multiple modes with minimal conflict or delay.

Table 38: Summary table of pedestrian behaviour at N Steyne and S Steyne, Manly (bi-direction statistics)

Location	N Steyne and S Steyne (East footpath)	N Steyne and S Steyne (West footpath)	N Steyne and S Steyne (East/west crossing)	The Corso Intersection (North/ South crossing)
Weekdays				
Average Pedestrian Volumes (peds/hr)	849	919	1520	438
Max Peak (peds/hr)	1076	1397	2149	668
Average Dwell Time (s)	204	237		
Maximum Dwell Time (s)	214	262		
Average Crossing Time (s)			131.72	169.61
Weekends				
Average Pedestrian Volumes (peds/hr)	1415	1388	2366	561
Max Peak (peds/hr)	2054	1950	3288	758
Average Dwell Time (s)	242	258		
Maximum Dwell Time (s)	299	312		
Average Crossing Time (s)			5.30	5.36

Table 38 summarises the pedestrian activity. Pedestrian activity along North Steyne and South Steyne is exceptionally high, consistent with its role as a Connector Street that links key recreational and commercial destinations in Manly. Weekday pedestrian volumes averaged 850–920 pedestrians per hour along footpaths and exceeded 1,500 per hour at key crossings, with weekend activity increasing markedly to over 1,300 pedestrians per hour on footpaths and more than 2,300 per hour at crossings.

Average dwell times ranged between 200 and 260 seconds, indicating active street engagement. Crossing times were longer at The Corso intersection, reflecting high pedestrian demand and shared space dynamics. Overall, these patterns confirm the street's strong place function, supporting continuous pedestrian movement and extended recreational use.

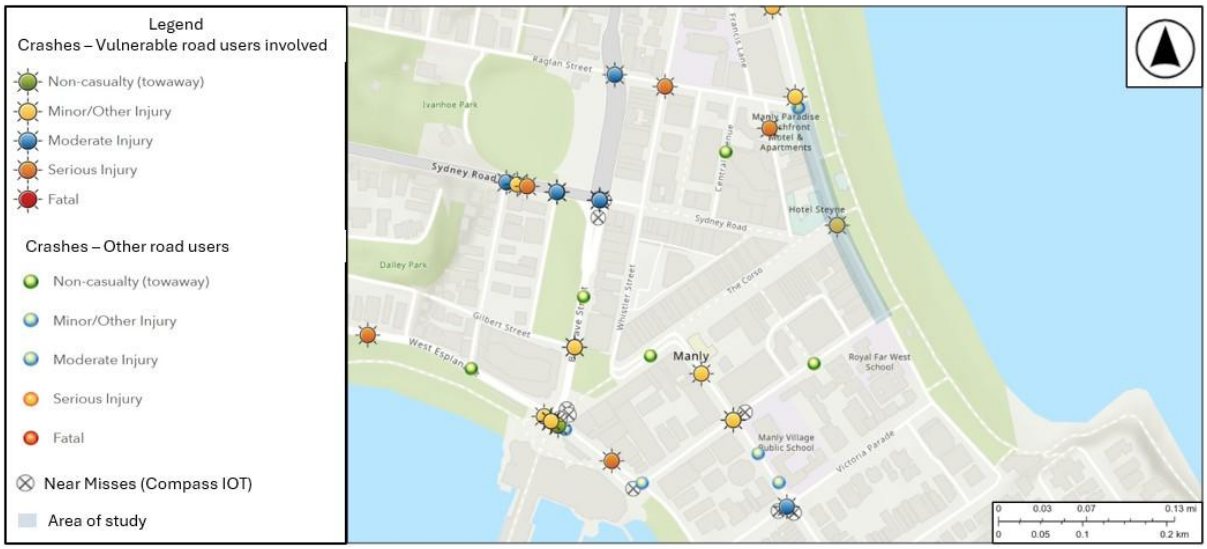


Figure 33: Safety map of N Steyne and S Steyne, Manly (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 33 illustrates the safety profile of the study area, showing three recorded crashes, two involving vulnerable road users, none of which resulted in serious injury. In contrast, nearby corridors such as Belgrave Street exhibit a significantly higher crash frequency, including several severe incidents involving pedestrians and cyclists. This comparison indicates that the study site performs favourably in terms of safety, likely reflecting effective design features that help mitigate crash risk and enhance protection for vulnerable users.

Table 39: Summary of intercept survey results for N Steyne and S Steyne, Manly

		5	4	3	2	1	"I don't know"	Total
Sample Size	**75**							
Functionality for Activities (Average Rating)		25.5%	34.8%	13.9%	14.7%	3.7%	7.5%	100%
Suitability of Features (Average Rating)		22.5%	45.8%	10.8%	12.5%	5.3%	3.1%	100%
Suitability for Community		32.0%	49.3%	1.3%	9.3%	8.0%	0.0%	100%
Overall Safety		33.3%	48.0%	6.7%	8.0%	2.7%	1.3%	100%

Table 39 summarises the aggregated results of the intercept survey, completed by 75 participants. Most respondents rated the study area positively, with 60.3% finding it functional for activities, 68.3% considering the street features suitable, and 81.3% describing it as both suitable for the community and safe. The only categories to receive mixed feedback were parking areas for cyclists and motor vehicles, where opinions were evenly divided between suitable and unsuitable.

Table 40: Summary of online survey results for the imagery of N Steyne and S Steyne, Manly

		5	4	3	2	1	"I don't know	Total
Sample Size	**141**							
Functionality for Activities (Average Ratings)		29.9%	33.5%	17.7%	12.5%	4.2%	2.2%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (51.1%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (46.8%) Parking areas for cyclists (bikes and e-bikes) (38.3%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with cyclists (52.5%) As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (52.5%) As a Cyclist (bikes and e-bikes): interactions with pedestrians (45.4%)							
Word Association (Top 3)	Happy, Beautiful, Noisy							

Table 40 presents the results of the online survey, where participants were provided with imagery of N Steyne and S Steyne, Manly. The results of the online survey mirrored the results received in the intercept survey. Most respondents rated the study area as functional for activities (63.4% rating activities as easy or very easy to perform). The online survey results also confirmed that parking areas for cyclist as one of the prioritising aspects for future improvements. Additionally, respondents highlighted interactions between vulnerable users (pedestrians and cyclist) and motor vehicles as key safety concerns.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- The street was universally viewed as a relaxing and vibrant area, with suggestions for additional facilities including public bathrooms and benches.
- Concerns were raised about the shared cycle path centring around near misses, speeding E-bikes, lack of protective gear among riders and inattentive pedestrian use.
- For improved safety, comments suggested a dedicated bike lane, lower speed limits, clearer signage and better enforcement.

4.1.3.2 Peats Ferry Road, Hornsby (C2)

Peats Ferry Road is an urban arterial with sections that incorporate placemaking features such as widened footpaths, pedestrian-scale lighting, planted medians, and signalised crossings. These treatments occur near key civic and retail destinations.



Figure 34: Site photographs of Peats Ferry Road, Hornsby

Figure 34 and Figure 35 describe the location. The assessment focuses on a 155-metre section of Peats Ferry Road, extending from the pedestrian crossing at Station Street in the south to the intersection with Coronation Street in the north. This segment accommodates high pedestrian activity due to its proximity to Hornsby Station and location within a busy commercial precinct. Key features of the site include:

- **High pedestrian activity area 40 km/h speed limit.**
- A widened footpath at the corners of Peats Ferry Road and Station Street, as well as at Peats Ferry Road and Dural Street, accommodating street furniture and garden beds lining the street.
- A variety of crossing treatments, such as a pedestrian crossing at the intersection with Station Street for access to Hornsby Station, an unmarked crossing at the intersection with Dural Street serving as a midpoint crossing, and a signalized crossing at the intersection with Coronation Street.
- Parallel street parking that facilitates access to local shops for motor vehicles.
- Regular bus services and the nearby Hornsby Station ensure that the area is accessible by all modes of transportation.

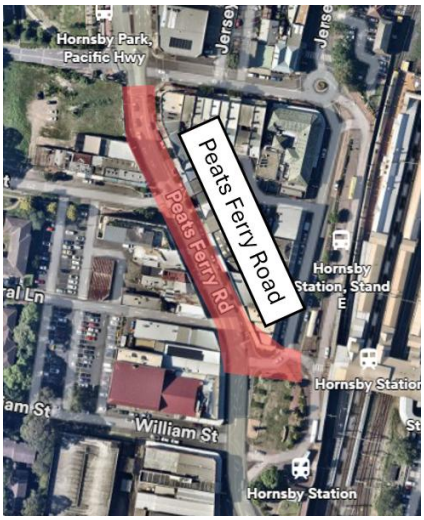


Figure 35: Site Map of Peats Ferry Road

OFFICIAL

Table 41: Summary table of pneumatic tube data at Peats Ferry Road, Hornsby (bi-direction statistics)

Location		Dural St (West of Peats Ferry Rd)	Peats Ferry Rd (Outside Property 179)	Dural Ln (West of Peats Ferry Rd)	Station St (East of Peats Ferry Rd)	Peats Ferry Rd (Outside Property 165)	William St (West of Peats Ferry Rd)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	2,110	14,747	350	1,442	13,749	4,361
	7-Day Average (vehicles/day)	2,177	14,091	329	1,406	13,221	4,280
	AM Peak (vehicles/hr)	153	1,104	44	150	957	309
	PM Peak (vehicles/hr)	117	563	43	0	594	265
	Max Peak (vehicles/hr)	223	1229	55	166	1169	470
Average Daily Cycling Volumes		23	165	15	19	112	25
Proportion of Heavy Vehicles (%)		0.6	5.5	7.9	3.2	3.3	2.8
Proportion of Cyclists + Motorcyclists (%)		0.9	1.2	4	1.3	0.8	0.6
Motorised Vehicle Speed	*85th Percentile*	20.5	36.0	21.1	14.2	34.6	32.8
	Average	15.9	28.3	15.7	11.4	28.9	26.4
Bicycle Speed	*85th Percentile*	26.9	21.6	15.3	16.9	29.2	25.5
	Average	17.4	14.9	10.6	11.7	20.0	14.5

Table 41 summarises the movement characteristics of Peats Ferry Road and adjoining streets including Dural Street, Dural Lane, Station Street, and William Street. Daily traffic volumes range from around 300 vehicles per day on Dural Lane to nearly 15,000 on Peats Ferry Road, reflecting its role as a key Connector Street linking residential areas, Hornsby Station, and the local commercial precinct. Observed vehicle speeds remained below the 40 km/h limit, with 85th percentile speeds between 20 and 36 km/h, suggesting effective speed moderation. Cycling activity was relatively low (less than 2%) but average cycling speeds were comparable to motor vehicles, indicating a shared environment.

Table 42: Summary table of pedestrian behaviour at Peats Ferry Road, Hornsby (bi-direction statistics)

Location	Peats Ferry Road (East footpath)	Peats Ferry Road (West footpath)	Peats Ferry Road (Station Street intersection footpath)	Peats Ferry Road (South signalised crossing)	Peats Ferry Road (North signalised crossing)
Weekdays					
Average Pedestrian Volumes (peds/hr)	190	233	1	34	388
Max Peak (peds/hr)	282	345	2	50	448
Average Dwell Time (s)	112	118	8		
Maximum Dwell Time (s)	121	126	12		
Average Crossing Time (s)				6.10	9.19
Weekends					
Average Pedestrian Volumes (peds/hr)	126	131	0	38	218
Max Peak (peds/hr)	193	204	0	66	312
Average Dwell Time (s)	100	112	0		
Maximum Dwell Time (s)	114	121	0		
Average Crossing Time (s)				5.89	9.19

Table 42 describes the pedestrian activity. Pedestrian activity along Peats Ferry Road was moderate, with higher volumes observed on the west footpath and between Coronation Street and Dural Lane, particularly during weekdays when peak flows exceeded 400 pedestrians per hour. Average dwell times ranged from 100 to 120 seconds, indicating short pauses and limited stationary use typical of a transit-oriented corridor. Crossing activity was concentrated at the two signalised intersections, with average crossing times of 6–9 seconds, reflecting efficient pedestrian movement across the corridor. Weekend volumes declined slightly but remained consistent with the area's mixed residential and commercial character.

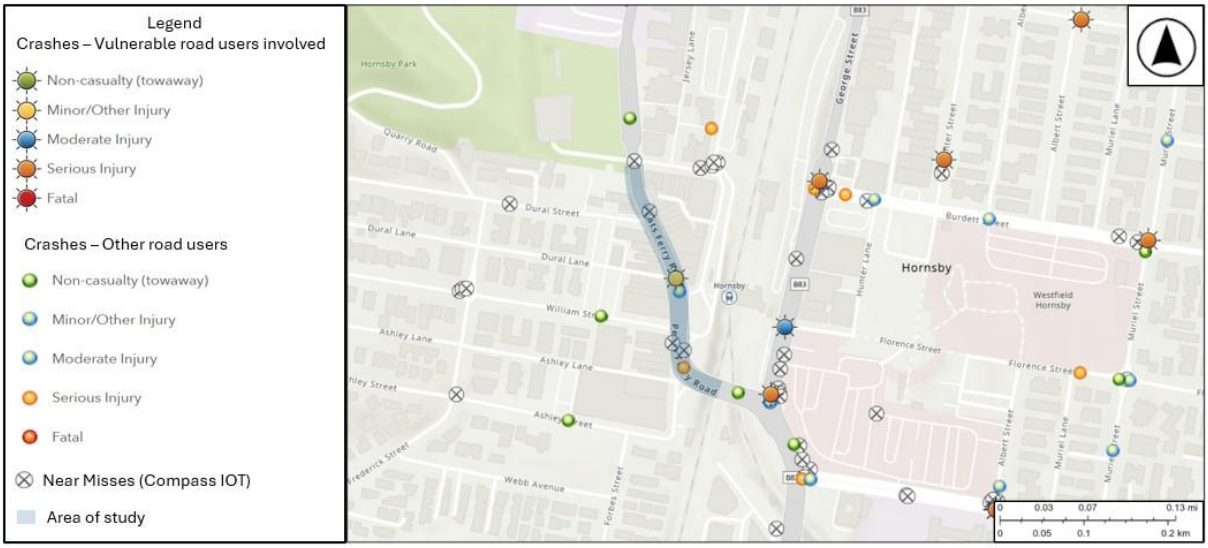


Figure 36: Safety map of Peats Ferry Road, Hornsby (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 36 presents the safety map for Peats Ferry Road and its adjoining intersections. A total of three crashes were recorded within the study area, including one incident involving a vulnerable road user, though no serious injuries were reported. The relatively low crash frequency suggests that the corridor performs well in terms of overall safety, particularly given its high pedestrian activity and proximity to Hornsby Station and the surrounding commercial area. This may reflect the influence of signalised crossings, reduced vehicle speeds, and clear sightlines, which collectively contribute to lower crash severity and safer pedestrian movements along the corridor.

Table 43: Summary of intercept survey results for Peats Ferry Road, Hornsby

		5	4	3	2	1	"I don't know "	Total
Sample Size	**97**							
Functionality for Activities (Average Rating)		7.2%	23.7%	19.5%	27.8%	16.7%	5.2%	100%
Suitability of Features (Average Rating)		8.7%	39.4%	15.8%	23.7%	10.4%	2.0%	100%
Suitability for Community		3.1%	43.3%	18.6%	24.7%	10.3%	0.0%	100%
Overall Safety		5.2%	46.4%	28.9%	12.4%	7.2%	0.0%	100%

Table 43 presents the results of the intercept survey for Peats Ferry Road, Hornsby, completed by 97 participants. Overall, respondents provided mixed evaluations of the street's performance. While nearly half rated the street features as suitable or very suitable (48.1%), and similar proportions viewed it as appropriate for the community (46.4%) and generally safe (51.6%), perceptions of functionality were less favourable. A total of 44.5% of respondents found activities difficult to perform, particularly those

related to relaxation, exercise, cycling, and activities involving children or people with disabilities. Cycling facilities and street furniture were consistently identified as unsuitable and highlighted as key areas for improvement.

Table 44: Summary of online survey results for the imagery of Peats Ferry Road, Hornsby

		5	4	3	2	1	"I don't know	Total
Sample Size	**134**							
Functionality for Activities (Average Ratings)		25.8%	37.2%	17.4%	14.1%	3.6%	1.9%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (58.2%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (46.3%) Areas for cyclists (bikes and e-bikes) to ride (45.5%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (64.9%) As a Pedestrian: interactions with cyclists (53.0%) As a Cyclist (bikes and e-bikes): interactions with pedestrians (47.0%)							
Word Association (Top 3)	Happy, Beautiful, Quiet							

Table 44 summarises the results of the online survey where respondents received photos of Peats Ferry Road, Hornsby. The online survey confirms with the intercept survey on “street furniture” and “areas for cyclists to ride” as key aspects of future improvements. Participants also flagged the interactions between vulnerable users (pedestrians and cyclists) and motor vehicles, as key safety concerns requiring attention. However, unlike the intercept survey, the online survey presented a more favourable view of the street’s functionality, with most participants, on average, rating activities either easy or very easy to perform (63% of responses).

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Congestion along Peats Ferry Road, with poor signal sequencing and high pedestrian volumes.
- Suggestion for longer durations of pedestrian crossing signals to improve pedestrian safety
  Improvements to be made to amenities including more public benches, rubbish bins and vegetation as well as better upkeep of plants to improve visibility.

4.1.3.3 Henderson Road, Edmondson Park (C3)

Henderson Road is a new Connector Street in the recently developed town centre precinct of Edmondson Park. The street includes formal cycling facilities, raised pedestrian crossings, landscaped verges, and integrated traffic calming. It connects the train station with residential, retail, and civic destinations.





Figure 37: Site photographs of Henderson Road, Edmondson Park

Figure 37 and Figure 38 illustrates the site area designated for assessment. Henderson Road runs along the entire length of the Edmondson Park Station, bordered by Soldiers Parade to the east and MacDonald Road to the west. The site encompasses the full expanse of Henderson Road, measuring 300 meters. Other key features include:

- **40 km/h speed limit signifying an area of high pedestrian activity.**
- Commuter car park is present at the corner MacDonald and Henderson Roads, with bus stands and bicycle racks providing access to the train station.
- Eastern Henderson Road lined with shops and high-density residential building.
- Pedestrian crossing west of Sergeant's Street connects the car park to the station. Wide footpaths, measuring 9.5 meters in width, are adorned with decorative paving, street furniture, and garden beds, creating a pedestrian-friendly environment and allowing ample space for outdoor dining at local cafes.

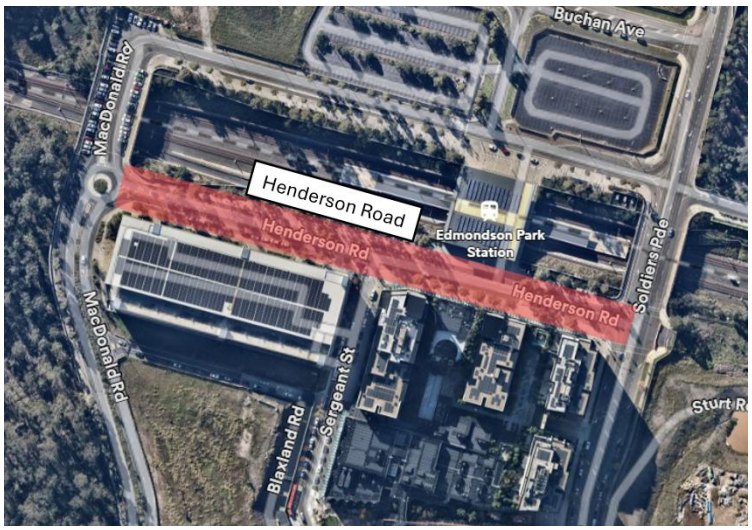


Figure 38: Site Map of Henderson Road

Table 45: Summary table of pneumatic tube data at Henderson Road, Edmondson Park (bi-direction statistics)

Location		Henderson Rd (East of Sergeant St)	Sergeant St (South of Henderson Rd)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	5,960	613
	7-Day Average (vehicles/day)	5,418	593
	AM Peak (vehicles/hr)	593	57
	PM Peak (vehicles/hr)	379	51
	Max Peak (vehicles/hr)	645	125
Average Daily Cycling Volumes		33	7
Proportion of Heavy Vehicles (%)		5.7	5.5
Proportion of Cyclists + Motorcyclists (%)		0.6	0.5
Motorised Vehicle Speed	*85^{th} Percentile*	38.0	23.8
	Average	31.1	19.2
Bicycle Speed	*85^{th} Percentile*	26.7	N/A
	Average	18.6	5.0

Table 45 summarises the movement statistics of vehicles and bicycles within the study area. Vehicle movement along Henderson Road shows moderate traffic activity consistent with its mixed commercial and residential function. Average daily volumes were approximately 6,000 vehicles per day east of Sergeant Street, decreasing to around 600 vehicles per day along Sergeant Street. Peak-hour flows reached 645 vehicles per hour, indicating concentrated commuter movement during the morning period. Heavy vehicles accounted for about 5–6% of total traffic, typical of local connector streets. Observed 85th percentile speeds were 38 km/h on Henderson Road and 24 km/h on Sergeant Street, both below the posted 40 km/h limit. Cycling activity was minimal, with average volumes below 35 cyclists per day. Due to the small sample size, it was not possible to calculate 85th percentile cycling speeds for Sergeant Street. Overall, the corridor supports moderate vehicle flow with limited cycling presence.

Table 46: Summary table of pedestrian behaviour at Henderson Road, Edmondson Park (bi-direction statistics)

Location	Henderson Road (North footpath)	Henderson Road (West of Sergeant Street footpath)	Henderson Road (East of Sergeant Street footpath)	Henderson Road (West of Sergeant Street crossing)	Henderson Road (East of Sergeant Street crossing)	Sergeant Street (South of Henderson Road crossing)
Weekdays						
Average Pedestrian Volumes (peds/hr)	153	136	123	187	57	36
Max Peak (peds/hr)	338	483	269	478	133	50
Average Dwell Time (s)	129	85	118			
Maximum Dwell Time (s)	134	90	125			
Average Crossing Time (s)				5.68	9.25	6.55
Weekends						
Average Pedestrian Volumes (peds/hr)	76	25	53	40	27	21
Max Peak (peds/hr)	119	39	76	64	42	33
Average Dwell Time (s)	145	60	119			
Maximum Dwell Time (s)	196	80	132			
Average Crossing Time (s)				6.66	10.07	6.86

Pedestrian activity is presented in Table 46. There are moderate movements of pedestrians, with noticeable weekday peaks reflective the proximity to Edmondson Park Station and nearby bus services. Weekday volumes averaged between 120 and 190 pedestrians per hour, with peaks exceeding 450 pedestrians per hour near the Sergeant Street crossing, indicating concentrated commuter movement during peak periods. Average dwell times ranged from 85 to 130 seconds, suggesting short pauses typical of waiting or transitional behaviour. Crossing times averaged between 5 and 9 seconds, reflecting efficient pedestrian movement across the corridor. Weekend activity was considerably lower, averaging fewer than 80 pedestrians per hour, consistent with reduced commuting demand and more limited local use.

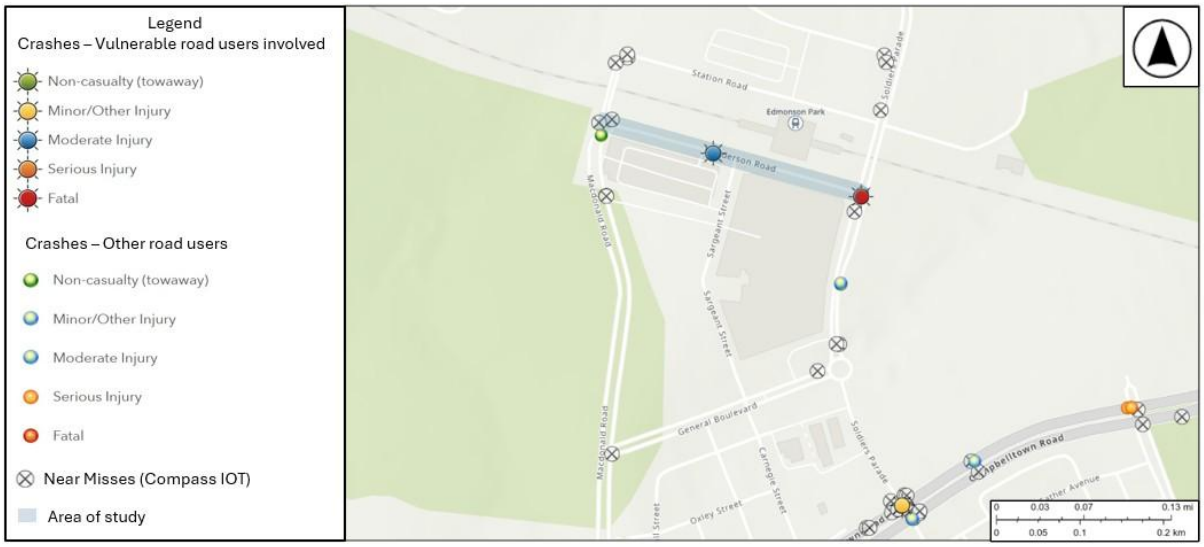


Figure 39: Safety map of Henderson Road, Edmondson Park (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 39 presents the safety map for the study area, showing a total of six near misses and three recorded crashes, two involving vulnerable road users. One incident in 2020, involving a car and a motorcycle, tragically resulted in a fatality. In contrast, nearby links experienced a greater number of near misses and three additional crashes, all resulting in minor or no injuries.

Table 47: Summary of intercept survey results for Henderson Road, Edmondson Park

		5	4	3	2	1	"I don't know"	Total
Sample Size	**56**							
Functionality for Activities (Average Rating)		18.5%	31.8%	20.8%	12.8%	10.4%	5.7%	100%
Suitability of Features (Average Rating)		21.0%	45.6%	10.4%	12.6%	6.0%	4.4%	100%
Suitability for Community		16.1%	57.1%	16.1%	8.9%	1.8%	0.0%	100%
Overall Safety		8.9%	58.9%	19.6%	10.7%	1.8%	0.0%	100%

Table 47 summarises the intercept survey results, based on responses from 56 participants. Overall, perceptions of the street were positive, with half of respondents (50.3%) finding it functional for everyday activities, and strong agreement that it has suitable street features (66.6%), is appropriate for the community (73.2%), and provides a satisfactory level of safety (67.8%). Most design elements were viewed favourably; however, opinions on cycling infrastructure were divided, with respondents evenly split between those rating it suitable and unsuitable.

Table 48: Summary of online survey results for the imagery of Henderson Road, Edmondson Park

		5	4	3	2	1	"I don't know	Total
Sample Size	**139**							
Functionality for Activities (Average Ratings)		29.6%	33.9%	16.1%	12.7%	6.5%	1.2%	100.0%
Aspect Prioritisation (Top 3)	Street furniture (benches, bus stop shelters, garbage bins, etc) (54.7%) Areas for cyclists (bikes and e-bikes) to ride (53.2%) Parking areas for cyclists (bikes and e-bikes) (41.7%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (59.7%) As a Pedestrian: interactions with cyclists (50.4%) As a Cyclist (bikes and e-bikes): interactions with motor vehicles (cars, bus, truck, etc) (47.5%)							
Word Association (Top 3)	Happy, Beautiful, Quiet							

Table 48 summarises the online survey results where respondents were shown imagery of Henderson Road, Edmondson Park. Similar to most of the other case study sites, the results of the online survey mirror the intercept survey. The functionality for activities received an overall satisfactory rating (63.5% favourable responses). The online survey also confirmed that cyclist infrastructure as a key aspect for improvement. Additionally, respondents noted that interactions between vulnerable users (pedestrians and cyclists) and motor vehicles are key safety concerns, suggesting that safety can be improved in these areas.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Henderson Road was praised for being a clean and pleasant street.
- Participants suggested improvements such as the addition of public benches and ramps to improve accessibility for vulnerable members of the community.
- Poor connectivity between public transport, the nearby town centre and surrounding residential areas.
- Additional pedestrian crossings outside the bus stop and train station were recommended to improve pedestrian safety and accessibility.
- Frequent stop in ‘No Stopping’ zones, causing congestion was noted, suggesting a dedicated pick-up/drop-off zone near the station.

4.1.4 Intersections within Shared Environments

4.1.4.1 Esplanade / Belgrave Street, Manly (I1)

This intersection lies at the centre of the Manly Wharf precinct, linking ferry, bus, and retail areas. The design features level paving, continuous pedestrian paths, integrated tactile markers, and informal crossing points within a high pedestrian activity environment.



Figure 40: Site photographs of West Esplanade / East Esplanade / Belgrave Street, Manly

Figure 40 shows the area selected for assessment, centred on the junction of East Esplanade, West Esplanade, Belgrave Street, and The Corso at Manly Wharf. East and West Esplanade run along the waterfront and meet at the wharf, while Belgrave Street provides vehicle access from the wider Manly area. The Corso connects directly to this point as a pedestrian-only link to the beach and surrounding commercial centre. The assessment covers approximately 120 metres of roadway across the three streets and an additional 40 metres along The Corso. Key features of the site include:

- **A high pedestrian activity area with a speed limit of 30 km/h throughout Manly**.
- Pedestrian promenade along Manly Wharf and The Corso with street furniture, landscaping, outdoor dining, lighting, and bicycle racks, creating a vibrant social hub.
- Manly Wharf operates as a major transport interchange, connecting ferry and bus services to surrounding suburbs and key Sydney destinations.
- The mixed-use CBD combines residential, retail, tourism, and service land uses.
- The intersection includes three signalised pedestrian crossings across West Esplanade, East Esplanade, and Belgrave Street.



Figure 41: Site map of West Esplanade / East Esplanade / Belgrave Street, Manly

Table 49: Summary table of pneumatic tube data on the approaches to the intersection of West Esplanade / East Esplanade / Belgrave Street, Manly (bi-direction statistics)

Location		West Esplanade (West of Belgrave St)	Belgrave St (North of West Esplanade)	East Esplanade (East of Belgrave St)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	9,415	9,763	13,298
	7-Day Average (vehicles/day)	9,492	10,042	13,454
	AM Peak (vehicles/hr)	758	742	1,004
	PM Peak (vehicles/hr)	497	422	516
	Max Peak (vehicles/hr)	856	877	1,347
Average Daily Cycling Volumes		452	305	419
Proportion of Heavy Vehicles (%)		5.7	6.5	9.1
Proportion of Cyclists + Motorcyclists (%)		4.9	3.2	3.4
Motorised Vehicle Speed	*85th Percentile*	35.2	32.8	34.2
	Average	26.9	25.7	26.1
Bicycle Speed	*85th Percentile*	27.5	17.4	27.5
	Average	18.4	11.6	19.1

Table 49 summarises the vehicle and bicycle movement characteristics for West Esplanade, East Esplanade, and Belgrave Street. Average daily traffic volumes range between 9,500 and 13,500 vehicles per day, with weekend peaks reflecting the area's strong recreational and visitor function. These volumes are consistent with the DORAS Shared Intersections typology, which prioritises the safe integration of pedestrians, cyclists, and vehicles in high-activity civic areas. The posted speed limit of 30 km/h is generally well observed, with 85th percentile speeds between 33 and 35 km/h and average speeds around 26 km/h. Cycling volumes were substantial, averaging 300 - 450 cyclists per day, with speeds slightly lower than motor vehicles. Overall, the results suggest a balanced multimodal environment where all users can move efficiently with minimal conflict.

Table 50: Summary table of pedestrian behaviour on the approaches to the intersection of West Esplanade / East Esplanade / Belgrave Street, Manly (bi-direction statistics)

Location	Esplanade (South footpath)	Esplanade (West of Belgrave Street footpath)	Esplanade (East of Belgrave Street footpath)	Esplanade (North crossing to Belgrave Street)	Esplanade (South crossing to Belgrave Street)	Esplanade (Belgrave Street crossing)
Weekdays						
Average Pedestrian Volumes (peds/hr)	864	250	835	272	1529	148
Max Peak (peds/hr)	1284	471	1224	447	1950	164
Average Dwell Time (s)	268	167	294			
Maximum Dwell Time (s)	291	186	321			
Average Crossing Time (s)				10.00	11.83	12.07
Weekends						
Average Pedestrian Volumes (peds/hr)	1330	227	1229	318	2346	158
Max Peak (peds/hr)	2207	323	2080	450	3543	218
Average Dwell Time (s)	317	117	267			
Maximum Dwell Time (s)	347	122	337			
Average Crossing Time (s)				9.18	12.08	11.82

Pedestrian activity at the Esplanade–Belgrave Street intersection is exceptionally high, reflecting its role as a key gateway between Manly Wharf, The Corso, and the foreshore area. As summarised in Table

OFFICIAL

50, weekday volumes exceeded 1,500 pedestrians per hour at the southern crossing, increasing to more than 2,300 per hour on weekends, confirming the area's strong recreational and tourism focus. Footpath activity remained consistently high on both sides of the Esplanade, with average volumes between 800 and 1,300 pedestrians per hour. Average dwell times ranged from 160 to 300 seconds, suggesting frequent stopping and social interaction, while crossing times of 9–12 seconds indicate steady pedestrian flow through signalised crossings. Overall, the intersection supports continuous, high-intensity pedestrian movement characteristic of a DORAS Shared Intersection.

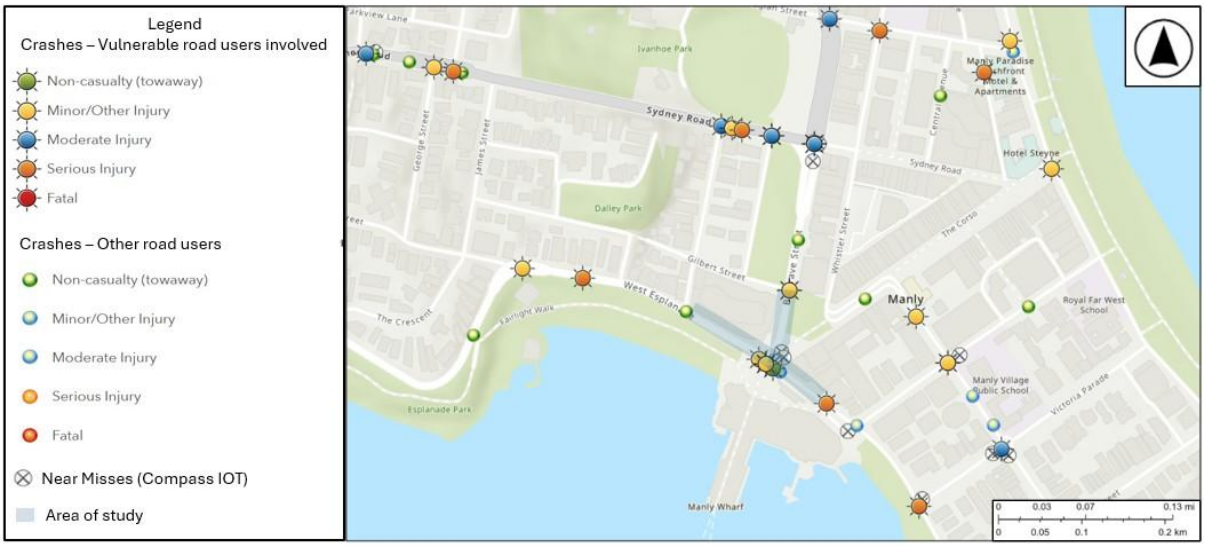


Figure 42: Safety map for West Esplanade / East Esplanade / Belgrave Street, Manly (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 42 presents the safety map for the intersection, showing a history of five near misses and five recorded crashes, including two involving vulnerable road users. None of these incidents resulted in fatalities or serious injuries. In contrast, adjacent links have experienced several crashes with more severe outcomes, indicating a higher relative risk across the surrounding network. This difference suggests that the lower operating speeds within the study area may be contributing to reduced crash severity and an overall safer environment for all users.

Table 51: Summary of intercept survey results for West Esplanade / East Esplanade / Belgrave Street, Manly

		5	4	3	2	1	"I don't know"	Total
Sample Size	**54**							
Functionality for Activities (Average Rating)		17.6%	24.1%	19.6%	22.2%	10.4%	6.1%	100%
Suitability of Features (Average Rating)		17.6%	39.9%	14.0%	18.7%	6.5%	3.3%	100%
Suitability for Community		20.4%	44.4%	13.0%	16.7%	5.6%	0.0%	100%
Overall Safety		14.8%	59.3%	9.3%	14.8%	1.9%	0.0%	100%

Table 51 presents the aggregated results of the intercept survey, completed by 54 participants. Overall, respondents viewed the study area positively, with 41.7% finding it functional for activities, 57.5% rating the street features as suitable, 64.8% considering it appropriate for the community, and 74.1% describing it as safe or very safe. However, participants highlighted cycling access and infrastructure, as well as vehicle parking, as key areas for improvement, noted by 63% of respondents.

Table 52: Summary of online survey results for the imagery of West Esplanade / East Esplanade / Belgrave Street, Manly

		5	4	3	2	1	"I don't know	Total
Sample Size	**142**							
Functionality for Activities (Average Ratings)		21.2%	27.2%	17.2%	19.5%	12.9%	2.1%	100.0%
Aspect Prioritisation (Top 3)		Street furniture (benches, bus stop shelters, garbage bins, etc) (50.7%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (50.0%) Areas for cyclists (bikes and e-bikes) to ride (47.9%)						
Key Safety Concerns (Top 3)		As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (69.7%) As a Pedestrian: interactions with cyclists (51.4%) As a Pedestrian: interactions with motorcyclists (51.4%)						
Word Association (Top 3)		Happy, Beautiful, Noisy						

Table 52 summarises the results of the online survey, in which respondents were shown imagery related the study area. The results of the online survey aligned with the results of the intercept survey. Functionality for activities received a satisfactory rating from participants (48.4% favourable responses). The online survey also reaffirmed that “areas for cyclist to ride” as a key aspect for improvement. Participants also raised concerns over interactions between pedestrians and other travel modes (bikes, cars, motorcycles, etc.), suggesting that pedestrian safety should be improved.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- The street was reported to be particularly busy on weekends with high pedestrian and vehicle volumes.
- Pedestrian safety was a common concern with suggestions to divert vehicles around Manly centre rather than through The Corso, or to pedestrianise the area in turn improving connectivity between Manly Wharf and Manly Beach.
- Comments recommended more trees along Corso to provide shade.
- Concerns were raised around E-bikes, with respondents wanting dedicated bike lanes to separate cyclists and pedestrians.

4.1.4.2 Anderson Street / Victoria Avenue, Chatswood (I2)

Situated in the core of the Chatswood commercial precinct, this intersection connects retail centres and public transport facilities. Design elements include wide pedestrian crossings, minimal kerbing, and shared surface features integrated into the intersection layout.

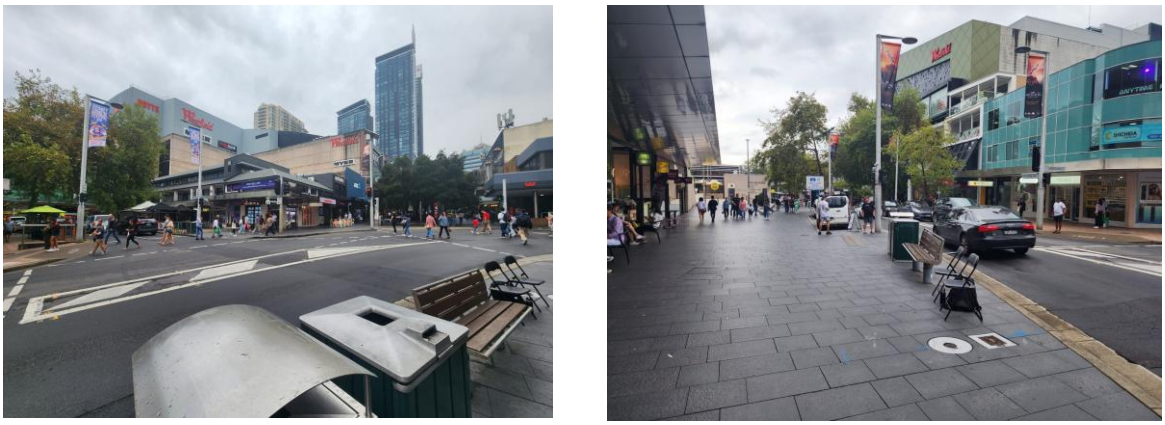


Figure 43: Site photographs of Anderson Street / Victoria Avenue, Chatswood

Figure 43 depicts the assessment area at the intersection of Victoria Avenue and Anderson Street. Victoria Avenue runs east–west, transitioning into a pedestrian promenade at Anderson Street, which continues north toward Albert Avenue. The analysis covered approximately 120 metres of roadway around the intersection and 40 metres of the adjoining promenade. Key features of the site include:

- **High pedestrian activity area with a 40 km/h speed limit.**
- The Western portion of Victoria Avenue provides access to Chatswood Station and bus stands.
- The southern portion of Anderson Street is one way (southbound) and bisects the adjacent shopping centre and its accompanying parking, facilitating vehicle access to the surrounding area.
- Numerous food markets and street vendors contribute to the vibrant atmosphere.
- The land surrounding the intersection of Victoria Avenue and Anderson Street is a dynamic, mixed-use, high-density urban precinct anchored by commercial, retail, and residential developments, which experience both high pedestrian and vehicle traffic.
- Wide footpaths with decorative paving enhance the junction's appearance and provide ample space for outdoor dining and street furniture.



Figure 44 Site map of Anderson Street / Victoria Avenue

Table 53: Summary table of pneumatic tube data on the approaches to the intersection of Anderson Street / Victoria Avenue, Chatswood (bi-direction statistics)

	Location	Anderson St (North of Victoria Ave)	Anderson St (South of Victoria Ave)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	7,440	3,780
	7-Day Average (vehicles/day)	7,265	3,781
	AM Peak (vehicles/hr)	551	359
	PM Peak (vehicles/hr)	208	325
	Max Peak (vehicles/hr)	626	405
Average Daily Cycling Volumes		247	94
Proportion of Heavy Vehicles (%)		6.3	2.4
Proportion of Cyclists + Motorcyclists (%)		3.4	2.6
Motorised Vehicle Speed	*85th Percentile*	29.3	23.9
	Average	23.4	17.8
Bicycle Speed	*85th Percentile*	24.9	23.4
	Average	17.0	18.1

Table 53 summarises the movement statistics of vehicles and bicycles within the study area. Vehicle movement along the Anderson Street – Victoria Avenue intersection reflects a moderate activity level consistent with its mixed commercial and pedestrian setting. Average daily traffic volumes were higher north of Victoria Avenue (approximately 7,400 vehicles per day) compared with south of Victoria Avenue (approximately 3,800 vehicles per day), where traffic operates as one-way southbound. Peak-hour flows reached 626 vehicles per hour in the northbound section, with lower but steady volumes in the southbound approach. Cycling activity was moderate, averaging 247 cyclists per day to the north and 94 to the south, indicating regular use by local commuters. Observed vehicle speeds were well below urban limits, with 85th percentile speeds of 29 km/h (north) and 24 km/h (south), suggesting effective speed moderation. Cycling speeds were comparable to vehicle speeds, indicating a shared environment with limited modal conflict.

Table 54: Summary table of pedestrian behaviour on the approaches to the intersection of Anderson Street / Victoria Avenue, Chatswood (bi-direction statistics)

Location	Anderson Street (Victoria Avenue intersection footpath)	Anderson Street (East footpath)	Anderson Street (North footpath)	Anderson Street (South signalised crossing)	Anderson Street (West crossing to Victoria Avenue)	Anderson Street (East crossing to Victoria Avenue)
Weekdays						
Average Pedestrian Volumes (peds/hr)	1369	598	533	1168	1187	144
Max Peak (peds/hr)	1810	866	883	1587	1658	261
Average Dwell Time (s)	148	158	125			
Maximum Dwell Time (s)	153	236	132			
Average Crossing Time (s)				4.90	9.11	5.82
Weekends						
Average Pedestrian Volumes (peds/hr)	1721	934	804	1614	1583	262
Max Peak (peds/hr)	2773	1556	1340	2680	2414	425
Average Dwell Time (s)	153	193	125			
Maximum Dwell Time (s)	165	282	133			
Average Crossing Time (s)				5.31	9.67	6.10

Table 54 summarises pedestrian activity at the Anderson Street and Victoria Avenue intersection, highlighting consistently high levels of foot traffic throughout the day. Weekday pedestrian volumes exceeded 1,300 pedestrians per hour at the intersection footpath and 1,100–1,200 per hour at the two main crossings, reflecting the site's strong retail and transport connections. Activity increased further on weekends, with peak volumes surpassing 2,600 pedestrians per hour, particularly near the south signalised crossing. Crossing times averaged between 5 and 9 seconds, indicating steady and efficient pedestrian flow through the junction. Overall, the data confirm the intersection's role as a high-intensity pedestrian node consistent with the mixed-use character of the Chatswood town centre.

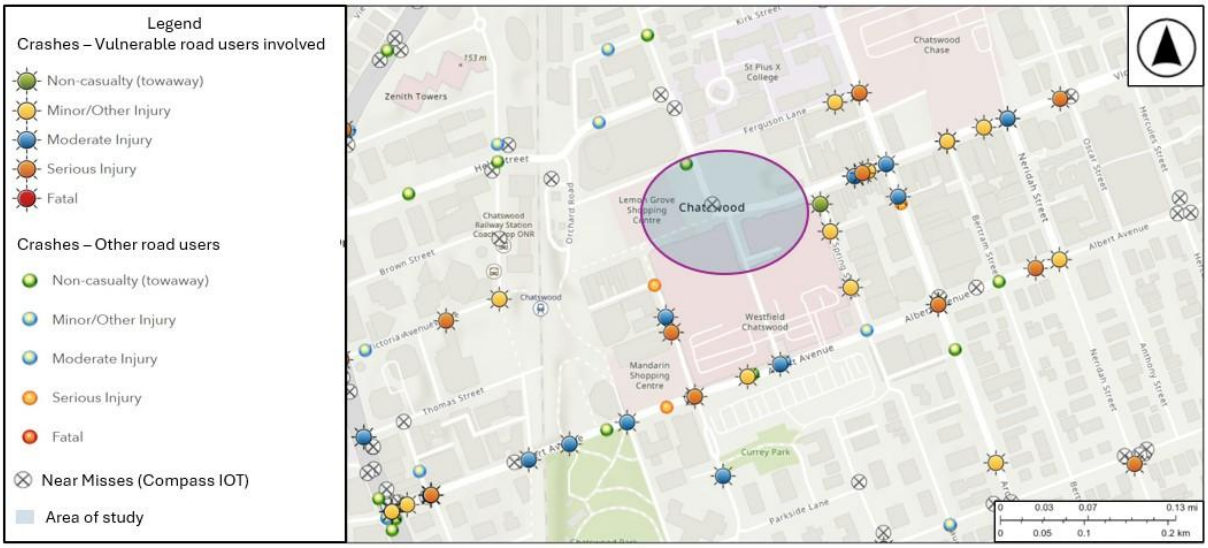


Figure 45: Safety map for Anderson Street / Victoria Avenue, Chatswood (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 45 presents the safety map for the intersection, illustrating a clear contrast between the study site and surrounding areas. While adjacent intersections have recorded a higher frequency of crashes, including several serious injuries, the target site demonstrates a notably safer profile. Between 2022 and 2023, only one near-miss incident was reported, with no recorded crashes. This pattern suggests that the site benefits from effective design and operational measures, contributing to improved safety performance compared with nearby locations.

Table 55: Summary of intercept survey results for Anderson Street / Victoria Avenue, Chatswood

		5	4	3	2	1	"I don't know"	Total
Sample Size	**47**							
Functionality for Activities (Average Rating)		13.3%	26.5%	20.2%	22.6%	10.8%	6.6%	100%
Suitability of Features (Average Rating)		13.7%	40.8%	15.6%	16.0%	8.2%	5.8%	100%
Suitability for Community		14.9%	59.6%	8.5%	12.8%	4.3%	0.0%	100%
Overall Safety		19.1%	53.2%	8.5%	14.9%	4.3%	0.0%	100%

Table 55 presents the aggregated results of the intercept survey, completed by 47 participants. Most respondents viewed the study area positively, with 54.5% rating its street features as suitable or very suitable, 74.5% considering it appropriate for the community, and 75.3% describing it as safe or very safe. However, cycling accessibility and infrastructure emerged as key areas for improvement, with 49% of participants rating them as unsuitable. Perceptions of overall functionality were more divided.

39.8% found activities easy to perform while 33.4% found them difficult, indicating that the street effectively supports some uses but remains less accommodating for others.

Table 56: Summary of online survey results for the imagery of Anderson Street / Victoria Avenue, Chatswood

		5	4	3	2	1	"I don't know	Total
Sample Size	**138**							
Functionality for Activities (Average Ratings)		20.4%	32.7%	17.2%	18.0%	9.2%	2.4%	100.0%
Aspect Prioritisation (Top 3)	Areas for cyclists (bikes and e-bikes) to ride (55.8%) Parking areas for cyclists (bikes and e-bikes) (48.6%) Street furniture (benches, bus stop shelters, garbage bins, etc) (48.6%)							
Key Safety Concerns (Top 3)	As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (59.4%) As a Pedestrian: interactions with cyclists (52.9%) As a Pedestrian: interactions with motorcyclists (52.2%)							
Word Association (Top 3)	Happy, Beautiful, Noisy							

Table 56 summarises the results of the online survey. Compared to the intercept survey, the online survey presented a more favourable view on the street's functionality for activities, with a majority of participants, rating activities either easy or very easy to perform (53.1% of responses). The online survey also reaffirmed that cycling infrastructures as key aspects for future improvements. In addition, participants flagged the interactions between pedestrians and other transport mode as key safety concerns that require attention.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Participants emphasised the importance of pedestrian safety, with a shared view that the streets should be further pedestrianised.
- Some respondents expressed concerns with the intersection between Anderson Street and Victoria Avenue, identifying shortcomings including narrow footpaths, driver confusion at the intersection, tight bus turns endangering pedestrians, and vehicle queues.
- Many respondents recommended full pedestrianisation of the street to assist in improving safety.
- Concerns were also raised surrounding the cleanliness of the street market, indicating the area becomes dirty and smelly at times.

4.1.4.3 Portman Street / Merton Street, Green Square (I3)

This intersection is part of the Green Square urban renewal area in Zetland. It includes level paving, continuous street surfacing, seating, landscaping, and features that encourage shared movement between pedestrians, cyclists, and vehicles in a mixed-use, high-density context.



Figure 46: Site photographs of Portman Street / Merton Street, Green Square

Figure 46 illustrates the site considered for assessment. Portman Street runs Northwest to Southeast, intersecting Merton Street Northeast to Southwest. The southwestern portion of Merton Street transitions into a one-way shared zone at the intersection. For this analysis, 20 meters in each direction of the intersection was considered, constituting 40 meters of Portman Street and 40 meters of Merton Street. Other key street features include:

- **40km/h speed limit.**
- Raised intersection with decorative paving and garden beds.
- Mixed-use, transitional urban environment combining heritage residential terraces**,** infill medium-density housing, and enhanced public domain and streetscape features, reinforcing connectivity and pedestrian amenity while accommodating controlled parking and low local traffic demand.

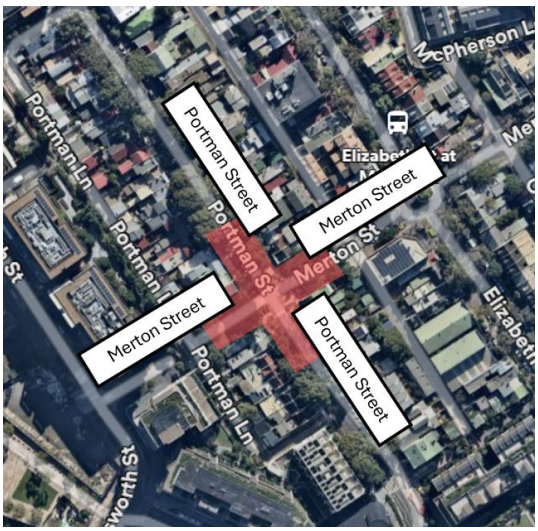


Figure 47 Site map of Portman Street / Merton Street, Green Square

Table 57: Summary table of pneumatic tube data on the approaches to the intersection of Portman Street / Merton Street, Green Square (bi-direction statistics)

Location		Portman St (North of Merton St)	Merton St (East of Portman St)	Portman St (South of Merton St)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	2,009	1,973	1,299
	7-Day Average (vehicles/day)	2,053	1,993	1,412
	AM Peak (vehicles/hr)	116	129	77
	PM Peak (vehicles/hr)	62	102	65
	Max Peak (vehicles/hr)	243	217	198
Average Daily Cycling Volumes		354	268	279
Proportion of Heavy Vehicles (%)		5.0	1.9	2.3
Proportion of Cyclists + Motorcyclists (%)		16.0	12.9	18.0
Motorised Vehicle Speed	*85th Percentile*	24.9	28.8	32.0
	Average	20.2	23.7	25.5
Bicycle Speed	*85th Percentile*	25.5	18.8	28.1
	Average	20.9	15.2	22.3

Table 57 summarises the movement statistics of vehicles and bicycles within the study area. Average daily traffic volumes range from approximately 1,300 to 2,000 vehicles per day across all approaches, with peak-hour flows reaching up to 240 vehicles per hour. Cycling activity is relatively high for a local street environment, averaging 270–350 cyclists per day, accounting for 13–18% of total traffic. Heavy vehicles represent a small share of movements (below 5%), reflecting predominantly local access traffic. Vehicle speeds remain low, with 85th percentile values between 25 and 32 km/h, aligning with a pedestrian-friendly setting. The similarity between cycling and vehicle speeds suggests that the street operates as a low-speed, mixed-traffic environment that naturally moderates movement without requiring additional control measures.

Table 58: Summary table of pedestrian behaviour on the approaches to the intersection of Portman Street / Merton Street, Green Square (bi-direction statistics)

Location	Portman Street (North footpath)	Portman Street (South footpath)	Portman Street (North of Merton Street crossing)	Merton Street (East of Portman Street crossing)	Merton Street (South of Portman Street crossing)
Weekdays					
Average Pedestrian Volumes (peds/hr)	6	5	35	15	63
Max Peak (peds/hr)	11	7	62	20	70
Average Dwell Time (s)	23	20			
Maximum Dwell Time (s)	42	26			
Average Crossing Time (s)			5.05	7.51	7.01
Weekends					
Average Pedestrian Volumes (peds/hr)	9	7	39	35	73
Max Peak (peds/hr)	18	13	53	50	117
Average Dwell Time (s)	26	21			
Maximum Dwell Time (s)	43	34			
Average Crossing Time (s)			4.72	6.87	6.82

Table 58 summarises pedestrian activity at the Portman Street / Merton Street intersection, showing low but steady pedestrian volumes consistent with a quiet residential environment. Weekday movements averaged 5–6 pedestrians per hour along the footpaths and up to 60 pedestrians per hour

OFFICIAL

at crossings, with slightly higher activity observed on Merton Street south of the intersection. Weekend volumes increased modestly, particularly at the crossings, reaching peaks of over 100 pedestrians per hour. Dwell times were short, averaging around 20–25 seconds, suggesting limited stationary activity. Average crossing times ranged between 5 and 7 seconds, indicating efficient pedestrian movement through the intersection. Overall, the data reflect light local foot traffic with minimal delays or congestion, typical of a low-speed neighbourhood setting.

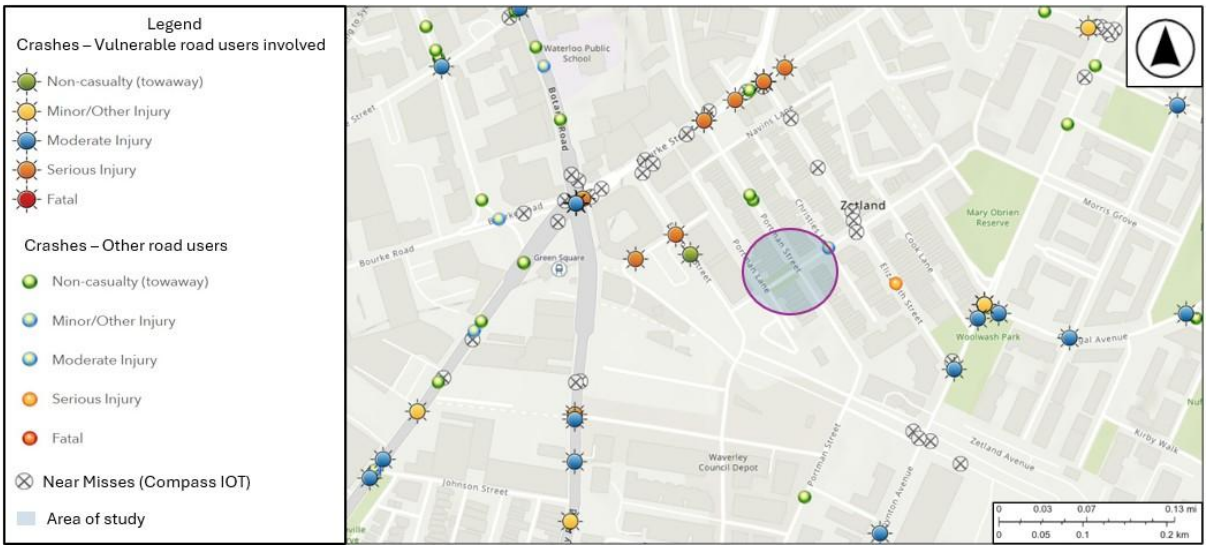


Figure 48: Safety map for Portman Street / Merton Street, Green Square (recorded crashes from 2019 to 2023 and near misses 2022 to 2023).

Figure 48 presents the safety map for the Portman Street / Merton Street intersection, illustrating a clear contrast in crash outcomes between the site and surrounding intersections. Between 2019 and 2023, nearby locations recorded several crashes, including a number involving serious injuries, whereas the target site experienced only one minor-injury crash during the same period. This pattern suggests that the intersection benefits from effective design and operational features, contributing to its strong safety performance relative to adjacent areas.

Table 59: Summary of intercept survey results for Portman Street / Merton Street, Green Square

		5	4	3	2	1	"I don't know"	Total
Sample Size	**75**							
Functionality for Activities (Average Rating)		15.3%	33.8%	18.3%	17.0%	6.8%	8.8%	100%
Suitability of Features (Average Rating)		15.2%	45.3%	11.9%	18.0%	5.4%	4.3%	100%
Suitability for Community		16.0%	54.7%	16.0%	8.0%	5.3%	0.0%	100%
Overall Safety		18.7%	53.3%	12.0%	14.7%	1.3%	0.0%	100%

Table 59 presents the intercept survey results, completed by 75 participants. Overall, respondents viewed the study area positively, with 49.1% finding it functional for activities, 60.5% rating its street features as suitable, 70.7% considering it appropriate for the community, and 72% describing it as safe or very safe. However, participants identified public transport access and parking infrastructure as key areas requiring improvement, noted by 45% of respondents.

Table 60: Summary of online survey results for the imagery of Portman Street / Merton Street, Green Square

		5	4	3	2	1	"I don't know	Total
Sample Size	**139**							
Functionality for Activities (Average Ratings)		21.7%	31.7%	18.7%	18.0%	7.8%	2.2%	100.0%
Aspect Prioritisation (Top 3)		Street furniture (benches, bus stop shelters, garbage bins, etc) (48.2%) Areas for cyclists (bikes and e-bikes) to ride (46.8%) Public transport accessibility (bus, tram, train, metro, ferry, etc) (42.4%)						
Key Safety Concerns (Top 3)		As a Pedestrian: interactions with motor vehicles (cars, bus, truck, etc) (61.2%) As a Pedestrian: interactions with cyclists (49.6%) As a Cyclist (bikes and e-bikes): interactions with motor vehicles (cars, bus, truck, etc) (49.6%)						
Word Association (Top 3)		Happy, Beautiful, Quiet						

Table 60 summarises the results of the online survey where participants were shown imagery of the study area. The results of the online survey align with the results of the intercept survey on the street's functionality for activities, with 53.4% rating activities either easy or very easy to perform. The online survey also confirms that "public transport accessibility" as a key area for improvement. Respondents also identified interactions between vulnerable users (pedestrians and cyclists) and motor vehicles as key safety concerns requiring attention.

The open-ended responses at the conclusion of both surveys revealed the following key points:

- Comments highlighted concerns regarding street features, maintenance and safety, with improvements to cycling infrastructure including bike racks and dedicated lanes being called for.
- Limited accessibility between Merton Street and Barker Street (west of the site) was indicated, with the only connection being via stairs posing a challenge for users.
- Concerns were raised about poor visibility caused by parked cars and inadequate street lighting, with suggestions to reduce parking and improve lighting for enhanced safety.
- Maintenance issues included leaf litter, and presence of bugs in park seating areas, with requests for more frequent maintenance.
- Numerous comments expressed confusion about how the shared intersection operates, noting that unclear give-way conditions contribute to reduced perceptions of safety among road users.

4.1.5 Summary of Findings

This section discusses and compares the findings across the twelve case study sites described in the previous sub-sections. The analysis integrates objective data on vehicle and pedestrian movements, safety outcomes, and survey-based perceptions, providing an overview of performance patterns across the diverse street types included in the study.

Objective movement data indicate broad consistency across sites in both vehicle and cycling behaviour. Pneumatic tube counts showed comparable average speeds for motorised vehicles and bicycles at most locations (except Henderson Road (C3)), suggesting a generally well-balanced coexistence between modes. The proportion of heavy vehicles and cyclists/motorcyclists was also similar across the case studies, typically ranging between 4 - 9% and 1–4%, respectively, with Chisholm Street (R1) and Portman Street (I3) sites being exceptions. Pedestrian movement patterns varied according to street hierarchy. Residential Lanes/Ways, Neighbourhood Streets, and Yield Streets exhibited notably lower pedestrian volumes, whereas higher-order streets, such as the Steyne (C1) and Esplanade (I1) corridors, recorded the highest activity levels. Across all sites, weekend pedestrian volumes were consistently greater than weekday volumes, though average dwell times showed no clear pattern,

suggesting that the nature of pedestrian activity may be site-specific and influenced by local context, land use, and amenities.

Safety analysis across the twelve sites revealed a generally strong performance. Almost all study areas recorded few crashes or near-miss events, with only one fatality reported across the entire dataset. In most cases, the sites exhibited lower crash frequencies and severities compared with surrounding corridors, indicating that design features such as reduced speeds, clear sightlines, and pedestrian priority have been effective in mitigating risk.

Survey results also revealed several consistent trends. In the online surveys, street furniture was the most frequently identified feature requiring improvement (except at the Anderson Street intersection (I2)). Cyclist infrastructure, public transport accessibility, and cycle parking were also commonly prioritised for enhancement. Safety concerns were dominated by pedestrian interactions with motor vehicles, followed by cyclist interactions with both pedestrians and vehicles. The most frequently used words to describe the streets were happy, beautiful, and quiet, although a few sites were more often described as noisy, reflecting local variation in context and use. The face-to-face (intercept) surveys showed slightly more variation in results but echoed similar themes regarding comfort, functionality, and the need for improved cycling infrastructure.

Overall, the findings suggest that while key patterns in movement, safety, and perceptions are broadly consistent across sites, several metrics, particularly pedestrian activity and dwell behaviour, are likely case-specific, reflecting the unique form and function of each street. The following section provides a comparative assessment of each DORAS street category considered in this research

4.1.5.1 Destination High Street

Across the three Destination High Street case studies, **respondents provided similarly positive face-to-face survey ratings for both functionality and suitability of features**, with 40–50% selecting the top two rating categories. Albert Street (D1) and Bankstown City Plaza (D3) achieved higher ratings for community suitability and perceived safety than Main Street (D3), suggesting that these outcomes are influenced not only by activity types or design features but also by the broader urban context and sense of place.

Objective movement data show that **all three streets support moderate vehicle activity and high pedestrian volumes, consistent with their role as mixed-use retail and social destinations**. Average vehicle speeds were generally within or below the 40 km/h limit on Albert Street (D1) and Main Street (D3). However, at **Bankstown City Plaza (D2), recorded 85th percentile speeds exceeded 20 km/h, indicating speeding within the 10 km/h shared zone**. This suggests that while vehicle volumes are low, the street design and driver behaviour may not fully reinforce the intended low-speed environment.

In both the online and intercept surveys, over 50% of respondents supported speed limits lower than the posted 40 km/h for Albert Street (D1) and Main Street (D2), and similar proportions viewed 10–20 km/h as appropriate for Bankstown City Plaza (D3), aligning with its shared zone classification. Across all three locations, a greater share of participants found it difficult or very difficult to exercise, cycle, or for children to play, compared with other street types. This indicates that while **Destination High Streets perform well in facilitating commerce and social interaction, they are less conducive to active or recreational uses**, particularly for vulnerable users such as children and cyclists.

4.1.5.2 Residential Lanes/Ways, Neighbourhood Streets, Yield Streets

The three residential case study sites; Chisholm Street (R1), Meehan Street (R2), and Private Street (R3), reveal important differences in functionality, safety, and community perception. Private Street (R3) achieved the highest ratings for both community suitability and overall safety across all twelve case studies, while Meehan Street (R2) recorded the lowest. These results were consistent with corresponding differences in street functionality and suitability of features from the face-to-face surveys.

However, the particularly high ratings for Private Street (R3) should be interpreted with caution, as the smaller sample size may have influenced the outcomes.

From the objective data, **all three sites exhibited low to moderate traffic volumes and low average speeds, typical of local residential environments**. Meehan Street (R2) showed average daily traffic volumes of around 2,000 vehicles, while Private Street (R3) had minimal motorised traffic and was primarily used for local access. Cyclist activity was relatively low across all three sites (however a high proportion at Chisholm Street (R1) which had low overall traffic), while pedestrian volumes were modest but noticeably higher on weekends, suggesting a stronger leisure or social function than weekday commuting. **In terms of safety, all three residential sites recorded few crashes or near-miss incidents, with no serious injuries reported during the observation period.** This aligns with the intent of residential street typologies within the DORAS framework, which aim to prioritise low vehicular traffic environments. While shared zone sites have been effective in lowering operating speeds and maintaining them within safe system ranges, instances of speeding were still observed at both sites (R1 and R3), with median speeds between 15 km/h and 20 km/h, above the posted 10 km/h limit but still substantially safer than typical urban speed environments. This pattern is consistent with observations from Bankstown City Plaza (D3).

Survey findings highlight several areas for improvement. In the online survey, Chisholm Street (R1) stood out, with respondents identifying areas for pedestrians to walk or dwell as the second most frequently cited feature requiring improvement, a pattern not observed at any other site. This, combined with the street's association with the word ugly (rather than beautiful), suggests that design or maintenance elements may be negatively affecting user perception and warrants closer examination to inform more pedestrian-friendly designs. Speed preferences further illustrate community sentiment toward safer, slower environments. More than 50% of respondents supported lower speed limits for Meehan Street (R2), where the current limit is 50 km/h, while around 30% of respondents viewed 10 km/h as appropriate for Chisholm Street (R1), matching its existing shared zone limit. Similarly, Private Street (R3), currently signposted at 10 km/h, received notable support for 30 km/h as an appropriate operating speed, suggesting that residents may perceive a comfortable balance between safety and movement. The results across these residential case studies **reinforce the importance of context-sensitive design, street aesthetics, and appropriate speed management in shaping perceptions of safety and usability in neighbourhood environments**.

4.1.5.3 Connector Streets

Across the Connector Street case studies (Steyne (C1), Peats Ferry Road (C2), and Henderson Road (C3)) survey results and objective data reveal notable variations in performance and community perception. **Steyne (C1) achieved consistently high ratings across all indicators, ranking second overall among the twelve case studies for functionality, suitability of features, community fit, and safety, second only to Private Street (R3)**. Given its larger sample size (n=75), Steyne (C1) provides a more reliable benchmark for understanding the qualities that contribute to a successful connector street, balancing high pedestrian volumes, active transport, and vehicle movement within a tourism-oriented setting. In contrast, Peats Ferry Road (C2) and Henderson Road (C3) **received lower scores for functionality and overall satisfaction, with respondents highlighting challenges related to street usability and comfort**. For Peats Ferry Road (C2), more than 50% of online survey participants believed the speed limit should be reduced from the current 40 km/h, reflecting safety concerns linked to its higher traffic volumes. Henderson Road (C3) showed slightly higher ratings for driving and public transport access, but lower scores for street-based activities such as dining or socialising, which could be attributed to the evolving nature of the Edmondson Park development.

Objective data confirmed that vehicle speeds across all three sites generally align with the 30–40 km/h range typical of connector streets. However, Henderson Road (C3) recorded a fatality at its entry point, underscoring the importance of intersection safety design and speed management near multimodal access nodes. For both **Peats Ferry Road (C2) and Henderson Road (C3), a large share of vehicle,**

pedestrian, and cycling movements are influenced by the proximity of nearby train stations, with activity patterns reflecting peak-period commuter behaviour and station access rather than local retail or leisure activity. In line with the NSW Speed Zoning Standard (Section 13.2.3), which outlines a treatment matrix linking speed environments with recommendations on primary and secondary safety measures, these locations may benefit from upgrading existing treatments, particularly at key pedestrian desire lines or transitions. For example, on Henderson Road (C3), an additional raised crossing east of the Seargent Street intersection could support safer crossing behaviour from the station to commercial and residential properties on the southern side. Overall, the Connector Street results demonstrate that while these corridors effectively facilitate through movement and local access, the most successful examples, such as Steyne (C1), are those that integrate strong pedestrian amenity, vibrant frontage uses, and clear speed control, ensuring safety and comfort for all users.

4.1.5.4 Intersections within a shared environment

The three Intersection case studies (Esplanade/Belgrave Street (I1), Anderson Street/Victoria Avenue (I2), and Portman Street/Merton Street) show consistent trends across both online and face-to-face surveys, with respondents generally satisfied with overall functionality and safety, while identifying opportunities to improve cycling infrastructure and street amenity.

Objective data highlight clear differences in traffic intensity and function. Esplanade/Belgrave Street recorded the highest traffic volumes (around 9,000–13,000 vehicles per day) and the greatest magnitude of cycling activity, while Anderson Street and Portman Street had more moderate levels of movement typical of local access streets. Vehicle speeds remained within the 25–35 km/h range, consistent with urban environments prioritising pedestrian safety. Notably, Portman Street had the second highest share of cyclists and motorcyclists (16–18%) among all twelve sites, indicating a strong preference for smaller and active modes. In terms of safety, the intersections performed well, with few crashes or near misses recorded during the study period. However, as mentioned earlier a fatality near the entry to Henderson Road highlights the importance of safety at intersections.

Survey findings were largely consistent across sites. Most participants viewed the speed limit at Esplanade/Belgrave Street as appropriate (only 10% suggested reductions), while 40–70% of respondents for Anderson Street and Portman Street supported lower limits, reflecting stronger concern for vulnerable users. Anderson Street differed in its improvement priorities, with respondents emphasising cycling infrastructure and parking (around 50%) alongside street furniture, whereas street furniture was the main issue at the other intersections. Both Esplanade and Anderson Street were described as noisy, contrasting with other street types where quiet was more common**. Overall, the intersection case studies indicate that while these sites perform strongly in terms of safety and user satisfaction, further attention to cycling provision, amenity maintenance, and noise management could enhance the experience of all users.**

Table 61 to Table 65 present aggregated comparisons of both objective and subjective data across all case study sites. The values represent site-level averages, offering a concise overview that practitioners can use to compare and benchmark performance against their own study areas.

Table 61: Summary of vehicle and bicycle movement characteristics across all twelve case study sites, grouped by DORAS typology

		Destination High Street			Residential Lanes/ Ways, Neighbourhood Streets, Yield Streets			Connector Streets			Intersections with a shared environment		
		Albert St (D1)	Main St (D2)	Bankstown Plaza (D3)	Chisholm St (R1)	Meehan St (R2)	Private St (R3)	Steyne (C1)	Peats Ferry Rd (C2)	Henderson Rd (C3)	Esplanade (I1)	Anderson Street (I2)	Portman St (I3)
Traffic Volumes (including cyclists)	*Weekday Average (vehicles/day)*	6,731	2,566	1,312	130	2,021	113	8,783	14,248	5,960	11	5,610	1,760
	7-Day Average (vehicles/day)	6,905	2,476	1,353	125	1,916	110	8,905	13,656	5,418	10,996	5,523	1,819
	AM Peak (vehicles/hr)	473	178	84	12	140	14	681	1,031	593	835	455	107
	PM Peak (vehicles/hr)	287	214	99	12	148	10	432	579	379	478	267	76
	Max Peak (vehicles/hr)	872	214	117	46	215	25	817	1,229	645	1,347	516	243
Average Daily Cycling Volumes		174	29	47	31	36	11	336	139	33	436	171	300
Proportion of Heavy Vehicles (%)		2.8	2.6	5.8	2.1	2.5	0.0	2.7	4.4	5.7	7.1	4.4	3.1
Proportion of Cyclists + Motorcyclists (%)		3.0	1.3	3.5	30.2	1.8	9.2	4.2	1.0	0.6	3.8	33.0	15.6
Motorised Vehicle Speed (km/h)	*85^{th} Perc.*	28.1	20.2	20.6	16.7	44.2	28.9	27.6	35.3	38.0	34.1	26.6	28.6
	Average	22.4	14.5	14.5	12.7	36.6	23.0	22.2	28.6	31.1	26.2	20.6	23.1
Bicycle Speed (km/h)	*85^{th} Perc.*	24.1	21.5	22.5	19.0	29.2	31.3	28.1	25.4	26.7	24.1	24.2	24.1
	Average	17.6	12.2	13.0	15.3	20.4	22.2	22.3	17.5	18.6	16.4	17.6	19.5

Table 62: Summary of pedestrian behaviour across all twelve case study sites, grouped by DORAS typology

	Destination high street			Residential Lanes/ Ways, Neighbourhood Streets, Yield Streets			Connector Streets			Intersections with a shared environment		
	Albert St (D1)	Main St (D2)	Bankstown Plaza (D3)	Chisholm St (R1)	Meehan St (R2)	Private St (R3)	Steyne (C1)	Peats Ferry Rd (C2)	Henderson Rd (C3)	Esplanade (I1)	Anderson Street (I2)	Portman St (I3)
Weekdays												
Average Pedestrian Volumes (peds/hr)	94	184	386	5	16	1	932	169	115	650	833	25
Max Peak (peds/hr)	175	453	773	25	45	2	2,149	448	483	1,950	1,810	70
Average Dwell Time (s)	104.25	94.33	61.00	0.00	83.50	15.00	220.50	79.33	110.67	243.00	143.67	21.50
Maximum Dwell Time (s)	145	114	87	0	104	42	262	126	134	321	236	42
Average Crossing Time (s)	6.23	5.44	5.24	5.72	9.47	N/A	150.67	7.65	7.16	11.30	6.61	6.52
Weekends												
Average Pedestrian Volumes (peds/hr)	172	106	518	5	7.	1	1,433	103	40	935	1,153	33
Max Peak (peds/hr)	228	306	1019	23	21	2	3,288	312	119	3,543	2,773	117
Average Dwell Time (s)	103.75	91.00	60.67	2.00	45.50	7.00	250.00	70.67	108.00	233.67	157.00	23.50
Maximum Dwell Time (s)	139	123	97	9	78	25	312	121	196	347	282	43
Average Crossing Time (s)	6.00	5.57	5.81	6.90	0.74	N/A	5.33	7.54	7.86	11.03	7.03	6.14

Table 63: Summary of face-to-face survey results across all twelve case study sites (combined results for rating 4 (*Safe*) and 5 (*Very Safe*))

	Destination high street			Residential Lanes/ Ways, Neighbourhood Streets, Yield Streets			Connector Streets			Intersections with a shared environment		
	Albert St (D1)	Main St (D2)	Bankstown Plaza (D3)	Chisholm St (R1)	Meehan St (R2)	Private St (R3)	Steyne (C1)	Peats Ferry Rd (C2)	Henderson Rd (C3)	Esplanade (I1)	Anderson Street (I2)	Portman St (I3)
Functionality for Activities (Average Rating)	49.20%	42.80%	46.70%	35.60%	46.00%	71.60%	60.30%	30.90%	50.30%	41.70%	39.80%	49.10%
Suitability of Features (Average Rating)	58.60%	50.40%	54.30%	49.20%	40.50%	75.70%	68.30%	48.10%	66.60%	57.50%	54.50%	60.50%
Suitability for Community	70.90%	53.90%	65.00%	61.70%	36.00%	83.40%	81.30%	46.40%	73.20%	64.80%	74.50%	70.70%
Overall Safety	69.30%	41.10%	67.50%	51.10%	28.00%	87.50%	81.30%	51.60%	67.80%	74.10%	72.30%	72.00%

Table 64: Summary of words most commonly associated with each street across all twelve case study sites based on online survey responses.

	Destination high street			Residential Lanes/ Ways, Neighbourhood Streets, Yield Streets			Connector Streets			Intersections with a shared environment		
	Albert St (D1)	Main St (D2)	Bankstown Plaza (D3)	Chisholm St (R1)	Meehan St (R2)	Private St (R3)	Steyne (C1)	Peats Ferry Rd (C2)	Henderson Rd (C3)	Esplanade (I1)	Anderson Street (I2)	Portman St (I3)
First word	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Happy
Second word	Beautiful	Beautiful	Beautiful	Ugly	Beautiful	Beautiful	Beautiful	Beautiful	Beautiful	Beautiful	Beautiful	Beautiful
Third word	Quiet	Quiet	Noisy	Quiet	Quiet	Quiet	Noisy	Quiet	Quiet	Noisy	Noisy	Quiet

OFFICIAL

Table 65: Summary of improvement priorities and key safety concerns identified through the online survey across all twelve case study sites.

	Destination high street			Residential Lanes/ Ways, Neighbourhood Streets, Yield Streets			Connector Streets			Intersections with a shared environment		
	Albert St (D1)	Main St (D2)	Bankstown Plaza (D3)	Chisholm St (R1)	Meehan St (R2)	Private St (R3)	Steyne (C1)	Peats Ferry Rd (C2)	Henderson Rd (C3)	Esplanade (I1)	Anderson Street (I2)	Portman St (I3)
First feature	Street furniture (59.4%)	Street furniture (53.6%)	Street furniture (62.0%)	Street furniture (48.3%)	Street furniture (61.4%)	Street furniture (60.8%)	Street furniture (51.1%)	Street furniture (58.2%)	Street furniture (54.7%)	Street furniture (69.7%)	Areas for cyclists to ride (55.8%)	Street furniture (48.2%)
Second feature	Areas for cyclists to ride (48.4%)	Areas for cyclists to ride (51%)	Public transport accessibility (49.3%)	Areas for pedestrians to walk or dwell (38.6%)	Areas for cyclists to ride (48.5%)	Public transport accessibility (55.9%)	Public transport accessibility (46.8%)	Public transport accessibility (46.3%)	Areas for cyclists to ride (53.2%)	Public transport accessibility (51.4%)	Parking areas for cyclists (48.6%)	Areas for cyclists to ride (46.8%)
Third feature	Public transport accessibility (47.7%)	Public transport accessibility (47.7%)	Areas for cyclists to ride (40.1%)	Public transport accessibility (37.9%)	Public transport accessibility (47.7%)	Areas for cyclists to ride (44.8%)	Parking areas for cyclists (38.3%)	Areas for cyclists to ride (45.5%)	Parking areas for cyclists (41.7%)	Areas for cyclists to ride (51.4%)	Street furniture (48.6%)	Public transport accessibility (42.4%)
First safety concern	As a Pedestrian: interactions with motor vehicles (57.8%)	As a Pedestrian: interactions with motor vehicles (63.4%)	As a Pedestrian: interactions with motor vehicles (69.7%)	As a Pedestrian: interactions with motor vehicles (69.7%)	As a Pedestrian: interactions with motor vehicles (56.8%)	As a Pedestrian: interactions with motor vehicles (62.2%)	As a Pedestrian: interactions with cyclists (52.5%)	As a Pedestrian: interactions with motor vehicles (64.9%)	As a Pedestrian: interactions with motor vehicles (59.7%)	As a Pedestrian: interactions with motor vehicles (69.7%)	As a Pedestrian: interactions with motor vehicles (59.4%)	As a Pedestrian: interactions with motor vehicles (61.2%)
Second safety concern	As a Pedestrian: interactions with cyclists (48.4%)	As a Pedestrian: interactions with cyclists (62.1%)	As a Pedestrian: interactions with cyclists (53.5%)	As a Pedestrian: interactions with motorcyclists (46.9%)	As a Pedestrian: interactions with cyclists (55.3%)	As a Pedestrian: interactions with cyclists (47.6%)	As a Pedestrian: interactions with motor vehicles (52.5%)	As a Pedestrian: interactions with cyclists (53.0%)	As a Pedestrian: interactions with cyclists (50.4%)	As a Pedestrian: interactions with cyclists (51.4%)	As a Pedestrian: interactions with cyclists (52.9%)	As a Pedestrian: interactions with cyclists (49.6%)
Third safety concern	As a Cyclist: interactions with pedestrians (47.7%)	As a Cyclist: interactions with pedestrians (52.9%)	As a Pedestrian: interactions with motorcyclists (52.8%)	As a Pedestrian: interactions with cyclists (44.8%)	As a Cyclist: interactions with pedestrians (43.2%)	As a Cyclist: interactions with motor vehicles (42.7%)	As a Cyclist: interactions with pedestrians (45.4%)	As a Cyclist: interactions with pedestrians (47.0%)	As a Cyclist: interactions with motor vehicles (47.5%)	As a Pedestrian: interactions with motorcyclists (51.4%)	As a Pedestrian: interactions with motorcyclists (52.2%)	As a Cyclist: interactions with motor vehicles (49.6%)

4.2 Subjective Data Analysis

The previous sections examined each case study site independently, integrating both objective and subjective findings to describe local conditions. In contrast, this section focuses specifically on the subjective data, analysing the perceptions and attitudes captured through the intercept and online surveys as a collective dataset. This broader analysis provides a deeper understanding of how users experience different street environments and the factors that influence their sense of safety, functionality, and community value

4.2.1 Intercept Survey

4.2.1.1 Descriptive Statistics

A total of **641 intercept survey responses** were collected across the 12 case study sites, comprising 380 weekday and 261 weekend responses. Residential street locations generally experienced limited foot traffic, which made it challenging to meet sample targets, whereas Destination High Streets were characterised by excessive pedestrian volumes, sometimes constraining survey participation due to high activity levels. Despite these variations, significant sample sizes were achieved across all four assessed road type typologies as shown in Table 66.

Table 66: Field intercept data sample details

Category	Sites	Site ID	Weekday		Weekend		Total	
Destination High Streets	Albert Street, Freshwater	**D1**	38	83	24	58	62	141
	Main Street, Blacktown	**D2**	21		18		39	
	Bankstown City Plaza, Bankstown	**D3**	24		16		40	
Residential Streets	Chisholm Street, Darlinghurst	**R1**	20	54	27	42	47	96
	Meehan Street, Granville	**R2**	20		5		25	
	Private Street, Greater Sydney	**R3**	14		10		24	
Connector Streets	N Steyne and S Steyne, Manly	**C1**	43	145	32	83	75	228
	Peats Ferry Road, Hornsby	**C2**	57		40		97	
	Henderson Road, Edmondson Park	**C3**	45		11		56	
Shared Intersections	Esplanade/Belgrave Street, Manly	**I1**	30	98	24	78	54	176
	Anderson Street/Victoria Av, Chatswood	**I2**	32		15		47	
	Portman Street/Merton Street, Green Square	**I3**	36		39		75	
Totals			**380**		**261**		**641**	

Responses consist of a diverse and balanced sample of respondents considering the key demographic attributes of age, employment status and gender. However, there was a slight over-representation of retirees (approximately 16%) and 53% of respondents were male. Overall, this can be considered as an adequate representation of the demographic qualities of New South Wales. Furthermore, the results will be compared with the parallel online subjective data collection which will ensure statewide representation quotas will be met.

Descriptive analysis of all 641 responses revealed that most activities are “easy” or “very easy” to perform across all the sites (Table 67), suggesting that functionality needs of the community have been met. The functions highlighted in pink were identified as relatively insufficient. These relate to users’ ability to cycle, access and use public transport, and for people with disabilities to navigate and use the road space effectively. It should be noted that the activities of “children playing” and “working” were met with some confusion where more than 10% of respondents selected the “I don’t know” option for this question (shaded in grey).

Table 67: Aggregated response proportions for the question, "How easy or difficult is it to perform the following activities on the street?"

	Relax	Use one's phone	Chat	Rest	Exercise	Cycle (bike or e-bike)	Sit	People with a disability to move and dwell	Read	Walk	Have a meal/ drink/snack	Children to play	Work	Drive a car	Ride on public transport (bus, tram, metro, etc)	People of all ages to move and dwell
Very hard to perform	11%	5%	3%	12%	15%	15%	10%	10%	11%	2%	5%	24%	16%	10%	9%	4%
Hard to perform	19%	14%	10%	25%	28%	25%	18%	21%	25%	6%	13%	28%	24%	21%	11%	13%
Neither hard nor easy	25%	19%	18%	22%	18%	15%	16%	16%	20%	14%	16%	15%	24%	22%	15%	23%
Easy to perform	27%	38%	40%	25%	20%	19%	35%	22%	29%	39%	39%	14%	13%	30%	33%	40%
Very easy to perform	17%	22%	28%	13%	15%	10%	20%	7%	11%	39%	27%	9%	5%	11%	21%	14%
I don't know	1%	3%	0%	2%	5%	16%	2%	23%	3%	0%	1%	10%	17%	6%	10%	6%

Table 68: Aggregated response proportions for the question, "How would you rate the following aspects for the street?"

	Public transport (bus, tram, train, metro, ferry, etc)	Areas for cyclists to ride	Number and/or speed of cyclists	Parking areas for cyclists	Street furniture (benches, bus stop shelters, garbage bins, etc)	Landscaping (trees, street planters, flower box etc)	Services and amenities (grocery store, coffee shop, etc)	Surrounding buildings (height, aesthetics, etc)	Number and/or speed of motor vehicles (car, motorbike, bus, etc)	Areas for motor vehicles to ride	Areas for pedestrians to walk or dwell	Number of pedestrians	Parking areas for motor vehicles	Designated pedestrian crossings	Signage (traffic lights, speed limits sign, etc)	Environmental comfort (street lighting, air quality, noise, smell, etc)	Cleanliness	Maintenance
VU	12%	13%	17%	15%	7%	5%	5%	5%	10%	7%	5%	4%	14%	7%	5%	8%	9%	8%
U	15%	30%	28%	27%	19%	12%	9%	10%	27%	20%	10%	9%	28%	16%	11%	17%	19%	14%
N	8%	13%	17%	13%	13%	13%	9%	13%	14%	16%	9%	13%	11%	10%	12%	13%	17%	17%
S	39%	26%	21%	21%	46%	47%	43%	50%	40%	44%	49%	52%	32%	51%	56%	44%	41%	49%
VS	20%	12%	7%	8%	15%	23%	33%	20%	9%	8%	27%	20%	8%	15%	12%	16%	14%	11%
IDK	6%	6%	10%	16%	2%	1%	1%	2%	1%	5%	0%	2%	6%	1%	3%	1%	0%	2%

Note: VU = Very Unsuitable, U = Unsuitable, N = Neither, S = Suitable, VS = Very Suitable, IDK = I don't know, T = Total

Table 68 presents the aggregated response proportions for the question "*How would you rate the following aspects for the street?*". Like the functionality question, participants generally found street aspects favourable, where over 60% of the sample selected the option "suitable" or "very suitable" across the list of aspects. However, a common trend appeared to both these questions. Participants were least impressed about cycling functionality and the associated infrastructure, particularly evident for the features of cyclist riding area (43% dissatisfaction), the numbers of cyclists' present (45% dissatisfaction) and parking areas for cyclists (42% dissatisfaction). This indicates that there is potential to improve accessibility and features associated with cycling across the case study sites.

As mentioned in Section 4.1.5, categorising the responses for each site revealed consistent response across most of the sites. Table 69 presents the response proportions for the overarching questions of "*Overall, the street we are standing on is…*" Participants indicated that most streets were suitable and safe for the community, where in general over 60% of responses were favourable (either very suitable, suitable or very safe, safe). However, Meehan Street in Granville was identified as a street that was both deemed unsuitable and unsafe by most of the respondents. The primary critique of this location is associated with the speed of vehicles traversing the road (inferred using the open-ended question requesting any further feedback placed at the end of the survey). **The results obtained from the survey could potentially be used to address such concerns by local and state government authorities**. It is worth highlighting that suitability of street and safety perceptions are correlated given the similarity in the distribution of ratings for the five-point scale across these two aspects.

Table 69: Suitability and safety response proportions across each 12 case study sites

	Total Samples	"Suitability"						"Safety"					
		Very suitable for the community	Suitable for the community	Neither unsuitable nor suitable for the community	Unsuitable for the community	Very unsuitable for the community	I don't know	Very safe for the community	Safe for the community	Neither safe nor unsafe for the community	Unsafe for the community	Very unsafe for the community	I don't know
Albert St (D1)	62	16.1%	54.8%	11.3%	8.1%	9.7%	0.0%	17.7%	51.6%	12.9%	12.9%	4.8%	0.0%
Main St (D2)	39	2.6%	51.3%	17.9%	12.8%	12.8%	2.6%	2.6%	38.5%	20.5%	23.1%	15.4%	0.0%
Bankstown Plaza (D3)	40	10.0%	55.0%	17.5%	10.0%	7.5%	0.0%	10.0%	57.5%	22.5%	5.0%	5.0%	0.0%
Chisholm St (R1)	47	14.9%	46.8%	14.9%	10.6%	10.6%	2.1%	6.4%	44.7%	23.4%	14.9%	8.5%	2.1%
Meehan St (R2)	25	0.0%	36.0%	12.0%	24.0%	28.0%	0.0%	0.0%	28.0%	36.0%	20.0%	16.0%	0.0%
Private St (R3)	24	66.7%	16.7%	0.0%	0.0%	16.7%	0.0%	58.3%	29.2%	4.2%	0.0%	8.3%	0.0%
Steyne (C1)	75	32.0%	49.3%	1.3%	9.3%	8.0%	0.0%	33.3%	48.0%	6.7%	8.0%	2.7%	1.3%
Peats Ferry Rd (C2)	97	3.1%	43.3%	18.6%	24.7%	10.3%	0.0%	5.2%	46.4%	28.9%	12.4%	7.2%	0.0%
Henderson Rd (C3)	56	16.1%	57.1%	16.1%	8.9%	1.8%	0.0%	8.9%	58.9%	19.6%	10.7%	1.8%	0.0%
Esplanade (I1)	54	20.4%	44.4%	13.0%	16.7%	5.6%	0.0%	14.8%	59.3%	9.3%	14.8%	1.9%	0.0%
Anderson St (I2)	47	14.9%	59.6%	8.5%	12.8%	4.3%	0.0%	19.1%	53.2%	8.5%	14.9%	4.3%	0.0%
Portman St (I3)	75	16.0%	54.7%	16.0%	8.0%	5.3%	0.0%	18.7%	53.3%	12.0%	14.7%	1.3%	0.0%
Total	641	16.2%	49.1%	12.8%	12.8%	8.7%	0.3%	15.4%	49.3%	16.8%	12.6%	5.5%	0.3%

4.2.1.2 Analysis of Text Responses

At the conclusion of the survey, participants were invited to provide additional feedback through an open-text box. Of the 641 intercept survey responses, 248 participants offered written comments, providing valuable insights into public perceptions of street design and suggested improvements from the perspective of road users. **These qualitative responses were analysed in NVivo and categorised into eight main themes and twenty-seven subthemes.** Where a single comment addressed multiple topics, relevant sections were coded separately under each applicable theme.

Given the large volume of feedback within the “Layout” category, this theme was further refined into six sub-subthemes to capture the diversity of issues raised. Conversely, the “Other” theme includes remarks outside the study’s scope, along with participant suggestions for improving survey implementation. Table 70 presents the distribution of comments by theme for the four street types.

For the three **Destination High Street** study sites, 106 text comments were received, with most focusing on design (42%) and safety (21%). Participants frequently called for better amenities, including more public bathrooms, bins, and the introduction of dedicated bike paths to separate cyclists from pedestrians. Some suggested further pedestrianisation to enhance community spaces. Safety-related feedback (22 comments) centred on improving nighttime security through increased police presence and measures to protect pedestrians from unsafe driver behaviour. Although the study areas were generally viewed positively, participants emphasised the need for cleaner streets, better road maintenance, and improved lighting to enhance both comfort and perceived safety.

Across the three **Residential Street Types** (Residential Lanes/ Ways, Neighbourhood Streets, Yield Streets), a total of 101 text comments were received, again with a majority placed an emphasis on both the design and safety (29% and 21% respectively). Respondents highlighted the value of street furniture such as benches and bins to make the spaces more inviting and functional for residents. Safety concerns focused on interactions between pedestrians, cyclists, and drivers, as well as general security issues. Some participants proposed installing security cameras, adding pedestrian crossings, and introducing traffic calming measures such as restricted vehicle access and lower speed limits. A further 15 comments addressed maintenance issues, including waste collection and vegetation management, while others expressed interest in better public transport connections to improve accessibility.

Feedback from the **Connector Street** sites was the most extensive, with 132 comments. The main themes were design (45%), traffic (16%), and safety (14%). Design-related suggestions included more parking areas, bike lanes, and increased pedestrian space to balance competing demands on the corridor. Traffic-related feedback (21 comments) focused on congestion during peak periods, with recommendations such as diverting traffic, reprogramming signal timings, and lowering speed limits to ease flow and improve safety. Safety-related concerns (18 comments) often mentioned right-of-way conflicts between road users, underscoring the need for clearer rules and infrastructure that better protect pedestrians.

For the **Shared Intersections**, 81 comments were received, most relating to design (32%) and safety (20%). Participants called for dedicated cycling lanes and greater pedestrian priority to improve usability and comfort. While most respondents considered these intersections generally safe, several expressed concern about E-bike behaviour and car-dominant layouts that compromise pedestrian safety. Others cited confusing signage and signal visibility issues as potential hazards for all users. Traffic-related feedback highlighted the impact of high vehicle volumes and speeding, both of which were seen as diminishing comfort and walkability within these shared environments.

Table 70: NVivo analysis of text comments gathered from the intercept survey

Themes and Subthemes	Destination High Streets	Residential Street Types	Connector Streets	Shared Intersections
Design	**45 (42%)**	**29 (29%)**	**60 (45%)**	**26 (32%)**
1. Accessibility (e.g. wheelchair access)	1 (1%)	1 (1%)	1 (1%)	1 (1%)
2. Amenities (addition or renewal of public toilets, benches, etc)	10 (9%)	9 (9%)	6 (5%)	2 (2%)
3. Building (e.g. height and aesthetics of surrounding buildings)	2 (2%)	0 (0%)	1 (1%)	0 (0%)
4. Development (e.g. current or planned development in the area)	2 (2%)	0 (0%)	11 (8%)	0 (0%)
5. Layout (e.g. street layout and features)				
5.1 Vegetation (e.g. additional vegetation)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
5.2 Bicycle Lane (e.g. additional bicycle lane, bike specific signage)	3 (3%)	0 (0%)	3 (2%)	2 (2%)
5.3 Divert Traffic (e.g. divert traffic on the surveyed street to nearby main roads)	0 (0%)	0 (0%)	2 (2%)	1 (1%)
5.4 Pedestrian Crossing (e.g. additional pedestrian crossing)	4 (4%)	8 (8%)	5 (4%)	2 (2%)
5.5 Pedestrianisation (e.g. further pedestrianise of the street, blocking vehicle access to the street)	5 (5%)	1 (1%)	7 (5%)	6 (7%)
5.6 Road Layout and features (e.g. change road design and traffic management features)	8 (8%)	3 (3%)	13 (10%)	4 (5%)
6. Parking (e.g. additional/ removal of parking spaces for better traffic flow)	2 (2%)	6 (6%)	4 (3%)	1 (1%)
7. Shops (e.g. nearby shops or shopping mall)	4 (4%)	0 (0%)	5 (4%)	4 (5%)
8. Signage and Signal (e.g. additional speed signs, change signal sequences)	3 (3%)	1 (1%)	2 (2%)	3 (4%)
Environment	**11 (10%)**	**7 (7%)**	**5 (4%)**	**2 (2%)**
1. Aesthetic (e.g. aesthetics of the study area)	11 (10%)	5 (5%)	4 (3%)	1 (1%)
2. Noise (e.g. noise related complaints)	0 (0%)	2 (2%)	1 (1%)	1 (1%)
Maintenance & Cleanliness	**11 (10%)**	**15 (15%)**	**4 (3%)**	**4 (5%)**
1. Cleanliness (e.g. level of cleanliness of the street, request for more frequent cleaning)	9 (8%)	10 (10%)	1 (1%)	2 (2%)
2. Plant Maintenance (e.g. request for better plant maintenance, overgrown trees, fallen leaves)	1 (1%)	4 (4%)	1 (1%)	1 (1%)
3. Road Condition (e.g. request for improving road condition, uneven road, blocked drainage)	1 (1%)	1 (1%)	2 (2%)	1 (1%)
Public Transport	**1 (1%)**	**5 (5%)**	**1 (1%)**	**1 (1%)**
1. Service Availability (e.g. request for public transport service in the area)	1 (1%)	4 (4%)	1 (1%)	1 (1%)
2. Service Timetable (e.g. requesting for renewal of existing public transport timetable)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Safety	**22 (21%)**	**21 (21%)**	**18 (14%)**	**16 (20%)**
1. Cyclist caused incident (e.g. speeding bikes)	3 (3%)	2 (2%)	2 (2%)	1 (1%)
2. Driver caused incident (e.g. speeding cars, cars not following traffic rules)	4 (4%)	1 (1%)	4 (3%)	5 (6%)
3. E-bike caused incident (speeding E-bikes, lack of attention by E-bike operators)	6 (6%)	5 (5%)	7 (5%)	5 (6%)
4. Pedestrian caused incident (e.g. pedestrians not paying attention on road)	0 (0%)	0 (0%)	4 (3%)	2 (2%)
5. Security (e.g. crime, unsafe encounter with shady characters in the area)	9 (8%)	13 (13%)	1 (1%)	3 (4%)
Traffic	**5 (5%)**	**11 (11%)**	**21 (16%)**	**9 (11%)**
1. Traffic flow (e.g. congestion, choke points in study area)	1 (1%)	2 (2%)	15 (11%)	5 (6%)
2. Vehicle speed (e.g. speeding cars, request for change of speed limits)	4 (4%)	9 (9%)	6 (5%)	4 (5%)
Visibility	**2 (2%)**	**7 (7%)**	**2 (2%)**	**2 (2%)**
1. Lighting (e.g. additional streetlights)	2 (2%)	7 (7%)	1 (1%)	1 (1%)
2. Visibility (e.g. blocked vision by overgrown plants and parked vehicles)	0 (0%)	0 (0%)	1 (1%)	1 (1%)
Other	**9 (8%)**	**6 (6%)**	**21(16%)**	**21 (26%)**
1. Survey Related (e.g. suggestions and comment regarding the survey context)	1 (1%)	2 (2%)	5 (4%)	4 (5%)
2. Unrelated, Unclear, NA (e.g. comments unrelated to the survey, unclear comments, or “No comment”)	8 (8%)	4(4%)	16 (12%)	17 (21%)
Total	**106 (100%)**	**101 (100%)**	**132 (100%)**	**81 (100%)**

4.2.1.3 Persona Analysis

Persona analysis is an important tool for understanding the diversity of travel behaviours and identifying common patterns of mode use that can inform user-centred street design. In this study, personas were developed based on participants' self-reported frequency of using different transport modes, using responses to the question "*How often do you [insert mode of transport activity]?*" with six frequency options ranging from "Never" to "Daily." **Among the 641 respondents, there were 346 unique combinations of mode use patterns, with 220 combinations specific to individual participants, reflecting high variability in travel behaviour.** The most common personas were characterised by regular car use (either as drivers or passengers) or by public transport users who reported infrequent use of other modes. Notably, cycling and motorbike use did not appear in any of the frequent combinations (occurring fewer than 7 times), suggesting these modes are less commonly integrated into regular travel routines across the case study sites.

As shown in Table 71, five person categories were identified for detailed analysis the categories consisted of samples more than 50 responses to ensure statistical significance.

Table 71: Persona Categories

Persona	Use Public Transport	Cycle	Motorbike	Travel as a car passenger	Drive	Sample Size
P1 – Cyclists	All Responses	Rarely Occasionally Sometimes Frequently Daily	All Responses	All Responses	All Responses	**265**
P2 – Motorcyclists	All Responses	All Responses	Rarely Occasionally Sometimes Frequently Daily	All Responses	All Responses	**73**
P3 – Users that don't cycle or motorbike	All Responses	Never	Never	All Responses	All Responses	**358**
P4 – Public and active transport users that limit driving	All Responses	All Responses	Never Rarely	Never Rarely	Never Rarely	**50**
P5 - Primarily uses private motor vehicles	Never Rarely	Never Rarely	All Responses	All Responses	All Responses	**107**

Overall, consistent patterns emerge across the personas. Table 72 presents the proportion of responses that selected "easy to perform" or "very easy to perform" across the different functions presented in the survey. There proportions are similar for all the personas, except for P4 and P5 that display some minor differences. Users that limit driving and generally use public or active transport (P4) believe that the case study street designs do not adequately support users with disabilities (16% acknowledgement of ease, compared to 27%-37% for other personas) but perceive that accessibility to public transport is easier. This is an intuitive result as these users limit driving. Contrastingly, people that primarily drive (P5) indicate the greatest difficulty in accessing public transport (36% acknowledgement of ease, compared to 49% - 64% for other personas), again a logical result based on the definition of the persona.

Table 72: Proportion of responses that selected "easy to perform" or "very easy to perform" across functionalities

Persona	Sample Size	Relax	Use one's phone	Chat	Rest	Exercise	Cycle (bike or e-bike)	Sit	People with a disability to move and dwell	Read	Walk	Have a meal/ drink/snack	Children to play	Work	Drive a car	Ride on public transport (bus, tram, metro, etc)	People of all ages to move and dwell
P1	265	46%	64%	70%	35%	35%	35%	58%	34%	42%	80%	62%	26%	18%	42%	50%	57%
P2	73	45%	60%	67%	49%	37%	32%	66%	37%	45%	74%	67%	33%	25%	36%	49%	63%
P3	358	42%	56%	66%	38%	35%	23%	52%	27%	38%	76%	67%	20%	18%	42%	57%	50%
P4	50	46%	54%	56%	36%	32%	30%	52%	16%	34%	72%	62%	20%	18%	34%	64%	54%
P5	107	47%	61%	67%	36%	42%	28%	50%	36%	38%	78%	63%	26%	19%	46%	36%	52%
All Data	**641**	**44%**	**59%**	**68%**	**37%**	**35%**	**28%**	**55%**	**30%**	**40%**	**78%**	**65%**	**23%**	**18%**	**42%**	**54%**	**54%**

Table 73: Proportion of responses that selected "suitable" or "very suitable" across street aspects/features

	Sample Size	Public transport access	Areas for cyclists to ride	Number and/or speed of cyclists	Parking areas for cyclists	Street furniture	Landscaping	Services and amenities	Surrounding buildings (height, aesthetics, etc)	Number and/or speed of motor vehicles	Areas for motor vehicles to ride	Areas for pedestrians to walk or dwell	Number of pedestrians	Parking areas for motor vehicles	Designated pedestrian crossings	Signage (traffic lights, speed limits sign, etc)	Environmental comfort	Cleanliness	Maintenance
P1	265	55%	44%	37%	31%	60%	69%	75%	69%	49%	57%	76%	73%	43%	65%	67%	63%	59%	64%
P2	73	55%	41%	37%	36%	60%	75%	77%	59%	44%	53%	78%	74%	47%	70%	66%	67%	64%	63%
P3	358	61%	34%	22%	27%	60%	69%	77%	71%	49%	49%	75%	71%	39%	66%	69%	57%	52%	56%
P4	50	58%	52%	32%	26%	64%	68%	82%	76%	50%	50%	80%	66%	42%	72%	58%	54%	48%	54%
P5	107	38%	36%	20%	18%	56%	63%	68%	62%	52%	50%	72%	70%	36%	67%	62%	56%	49%	49%
All Data	**641**	**59%**	**38%**	**28%**	**29%**	**60%**	**69%**	**76%**	**70%**	**49%**	**52%**	**76%**	**72%**	**41%**	**66%**	**68%**	**60%**	**55%**	**59%**

Similar results were observed for the questions related to suitability of the aspects of street design present at the case study sites. Table 73 presents proportion of responses that selected "suitable" or

"very suitable" across the different street aspects and features investigated in the survey. Across all defined personalities, responses within P5 (users that primarily drive) exhibited the least satisfaction of the suitability of the infrastructure provided, especially in the context of public transport and cycling (relatively low proportions for the first 4 categories in Table 73.

Table 74 presents the distribution of responses for the question, "*Overall, the street we are standing on is…*" across all five personas. As with the previous results, the pattern of responses is consistent across the personas where each persona generally believes that the sites are suitable and safe. P2 and P5 had the highest proportion of "unsuitability" ratings (25.2% and 26% respectively). P3 and P5 had the highest proportion of "unsafe" ratings (22.4% and 20.7%). **Again, this indicates that respondents that primarily use motor-vehicles are least satisfied with the case study sites**. As highlighted in past literature, this outcome is expected as the locations are prioritising multi-modal environments which involve lower speed environments and placing limitations for the movement of motorised vehicles.

Table 74: Response proportions for the question "Overall, the street we are standing on is..."

	Sample Size	Suitability Proportions						Safety Proportions					
		Very suitable for the community	Suitable for the community	Neither unsuitable nor suitable for the community	Unsuitable for the community	Very unsuitable for the community	I don't know	Very safe for the community	Safe for the community	Neither safe nor unsafe for the community	Unsafe for the community	Very unsafe for the community	I don't know
P1	265	16.2%	50.9%	10.6%	11.3%	10.6%	0.4%	17.0%	53.6%	14.3%	9.8%	5.3%	0.0%
P2	73	17.8%	46.6%	9.6%	13.7%	12.3%	0.0%	19.2%	42.5%	23.3%	9.6%	5.5%	0.0%
P3	358	15.9%	47.5%	14.5%	14.2%	7.5%	0.3%	14.5%	46.1%	18.2%	14.8%	5.9%	0.6%
P4	50	20.0%	48.0%	12.0%	14.0%	4.0%	2.0%	16.0%	52.0%	14.0%	8.0%	8.0%	2.0%
P5	107	22.4%	36.4%	15.0%	8.4%	16.8%	0.9%	16.8%	39.3%	21.5%	11.2%	11.2%	0.0%
All Data	**641**	**16.2%**	**49.1%**	**12.8%**	**12.8%**	**8.7%**	**0.3%**	**15.4%**	**49.3%**	**16.8%**	**12.6%**	**5.5%**	**0.3%**

Table 75: Response proportions for the question: "In your opinion, what would be an appropriate speed limit for motor vehicles on the street we are in?"

	Sample Size	10km/h	20km/h	30km/h	40km/h	50km/h	60km/h	Other
P1	265	15.5%	20.8%	26.4%	29.1%	6.0%	1.1%	1.1%
P2	73	13.7%	13.7%	31.5%	30.1%	5.5%	5.5%	0.0%
P3	358	14.8%	14.0%	28.2%	32.4%	7.0%	2.0%	1.7%
P4	50	26.0%	10.0%	38.0%	22.0%	2.0%	0.0%	2.0%
P5	107	12.1%	15.0%	29.0%	31.8%	7.5%	3.7%	0.9%
All Data	**641**	**15.0%**	**16.5%**	**27.5%**	**31.4%**	**6.6%**	**1.7%**	**1.4%**

Finally, the definition of the speed limit question also highlighted very similar responses across personas, as shown in Table 75. Active transport users (P1 and P4) tended to define lower speed limits compared to the other personas. P2 and P5 (personas that primarily use motorised vehicles) have the

highest proportion of the sample suggesting speeds of 50km/h or 60km/h (11% and 11.2%). Between 87.9% and 96% of each sample believes that the speed limit should be less than or equal to 40km/h. **This analysis suggests that the desire for speed limits less than 40km/h is independent of mode choice personas**. This will be analysed further in Section 4.2.3.

4.2.1.4 Correlation Analysis

A correlation analysis was undertaken to examine how the different response variables collected through the survey relate to each other. The aim was to identify whether one-to-one linear relationships exist that could directly explain participants' perceptions of the functionality, suitability and safety of the case study sites. All available variables were included in the analysis, and correlations were computed for sets of pairwise combination. This enabled a comprehensive evaluation across all possible relationships, rather than limiting attention to pre-specified hypotheses. Table 76 summarises the categories of variable combinations that were tested, example relationships examined are highlighted in the final column to clarify the purpose of each grouping. The full set of correlation values are presented in **Appendix D**.

Table 76: Variable combinations considered in correlation analysis of the intercept survey data

Variable Group 1	Variable Group 2	Example relationships examined
Demographics	Activities (Functionality)	• Age versus Walkability • Income versus Ability to Chat
Demographics	Safety Perceptions	• Age versus Pedestrian Safety • Income versus Driving Safety
Activities (Functionality)	Activities (Functionality)	• Walkability versus Ability to Chat • Relaxing versus Resting
Activities (Functionality)	Suitability	• Walkability versus Pedestrian Area Suitability • Ability to Chat versus Street Furniture Suitability
Activities (Functionality)	Safety Perceptions	• Walkability versus Pedestrian Safety • Ability to Chat versus Driving Safety
Suitability	Suitability	• Pedestrian Area Suitability versus Public Transport Accessibility • Street Furniture Suitability versus Cycling Parking Suitability
Suitability	Safety Perceptions	• Pedestrian area suitability versus Pedestrian Safety • Street Furniture Suitability versus Driving Safety
Objective Measures	Activities (Functionality)	• Vehicle Speeds versus Walkability • Pedestrian Counts versus Ability to Chat
Objective Measures	Suitability	• Vehicle Speeds versus Pedestrian area suitability • Pedestrian Counts versus Public Transport Accessibility
Objective Measures	Safety Perceptions	• Vehicle Speeds versus Pedestrian Safety • Pedestrian Counts versus Driving Safety

Most correlations were **weak** (< *0.2*), suggesting that no single variable has a dominant effect on perceptions or behaviours in public space. A few relationships reached **moderate strength** (*0.3–0.5*), particularly within clusters of related activities and between perceived suitability and safety. Very few exceeded 0.5. These patterns indicate that perceptions of safety and suitability are shaped by multiple overlapping influences, with limited explanatory power from any single pair of variables.

Table 77 highlights that the strongest correlations occur in four main domains:

- **Mode-related safety perceptions**: walking, cycling, and driving all show moderate-to-strong positive correlations with perceived safety, underscoring the strong link between **mode engagement and safety perception**.
- **Activity clusters**: social and passive behaviours (e.g chatting, relaxing, resting, resting) tended to co-occur.
- **Suitability and safety**: perceptions of walkability and comfort align strongly with perceptions of community safety.
- **Objective measures**: higher traffic volumes correspond with reduced social and active behaviours.

The analysis suggests that perceptions of safety, suitability, and activity patterns are not easily explained by single-variable relationships. While activity clusters and suitability–safety links display stronger associations, most correlations are weak, indicating that user experiences in public space are driven by more complex, multifactorial dynamics. These results point towards the need for multivariate modelling approaches to fully understand how demographics, behaviours, and environmental factors interact in shaping perceptions.

Table 77: Highest observed correlations within the intercept survey data

Relationship	Correlation	Description
Cycling Use and Cyclist Safety variables	0.70-0.73	Mode use and the respective safety variables all have significant positive correlations.
Motorbike Use and Motorbike Safety variables	0.82-0.84	
Car Driver Use and Car Driver Safety variables	0.49-0.61	
Relaxing and Resting	0.58	Social and passive behaviours align across the case study locations.
Phone Use and Chatting	0.63	
Overall Suitability and Community Safety	0.60	Strong positive correlations across these categories suggest that walkability and perceived suitability of infrastructure are key determinants for the perception of safety.
Pedestrian Areas and Community Safety	0.55	
Walking and Community Safety	0.53	
Traffic Volume and Chatting	-0.19	Higher traffic volumes have a slight tendency to suppress social and active travel behaviour.
Traffic Volume and Cycling	-0.17	
Average Speed and Driving	0.15	Weak positive correlation between higher speeds an environment where it is easy for driving.

4.2.2 Online Survey

A total of **1676 online survey responses** were collected, comprising 1008 responses from residents within Greater Sydney and 668 responses from residents outside of the Greater Sydney region, generally reflecting the population distribution of New South Wales. The target sample size for the overall online survey was 1600, with 400 responses required for each street design typology, this was achieved as detailed in Table 78. The demographic data for the respondents are showed in Table 79, Table 80, Table 81, and Table 82.

Table 78: Online survey data sample details

Typology	Sites	Site ID	Greater Sydney		Rest of NSW		Total	
Destination High Streets	Albert Street, Freshwater	**D1**	71	250	57	173	128	423
	Main Street, Blacktown	**D2**	92		61		153	
	Bankstown City Plaza, Bankstown	**D3**	87		55		142	
Residential Streets	Chisholm Street, Darlinghurst	**R1**	84	245	61	175	145	420
	Meehan Street, Granville	**R2**	78		54		132	
	Private Street, Metropolitan Sydney	**R3**	83		60		143	
Connector Streets	N Steyne and S Steyne, Manly	**C1**	72	250	69	164	141	414
	Peats Ferry Road, Hornsby	**C2**	87		47		134	
	Henderson Road, Edmondson Park	**C3**	91		48		139	
Shared Intersections	Esplanade/Belgrave Street, Manly	**I1**	90	263	52	156	142	419
	Anderson Street/Victoria Av, Chatswood	**I2**	86		52		138	
	Portman Street/Merton Street, Green Square	**I3**	87		52		139	
Totals			**1008**		**668**		**1676**	

Table 79: Gender distribution

Gender	Proportion
Man	50.1%
Woman	49.6%
Prefer not to say	0.2%
Non-binary	0.1%

Table 80: Age distribution

Age	Proportion
18 - 24	6%
25 - 34	21%
35 - 44	21%
45 - 54	17%
55 - 64	13%
65 - 74	10%
75 and above	6%

Table 81: Employment status distribution

Employment Status	Proportion
Employed full-time	64%
Employed part-time	10%
Self-employed	3%
Homemaker	5%
Retired	14%
Student	1%
Unemployed	2%
Other (please specify)	1%

Table 82: Income distribution

Income distribution	Proportion
Prefer not to say	3%
up to $18,200	2%
$18,201 to $45,000	9%
$45,001 to $90,000	18%
$90,001 to $135,000	30%
$135,001 to $190,000	23%
More than $190,000	16%

4.2.2.1 Functionality Analysis

Similar to the results of the field intercept survey, descriptive analysis of the online survey revealed that most activities are “easy” or “very easy” to perform across all the sites (Figure 50).

	Intercept Survey																Online Survey														
	Perform - Relax	Perform - Use one's phone	Perform - Chat	Perform -Rest	Perform - Exercise	Perform - Cycle (bike or e-bike)	Perform - Sit	Perform - People with a disability to move and dwell	Perform - Read	Perform - Walk	Perform - Have a meal/ drink/snack	Perform - Children to play	Perform - Work	Perform - Drive a car	Perform - Ride on public transport (bus, tram, metro, etc)	Perform - People of all ages to move and dwell	Perform - Relax	Perform - Use one's phone	Perform - Chat	Perform -Rest	Perform - Exercise	Perform - Cycle (bike or e-bike)	Perform - Sit	Perform - People with a disability to move and dwell	Perform - Read	Perform - Walk	Perform - Have a meal/ drink/snack	Perform - Children to play	Perform - Work	Perform - Drive a car	Perform - Ride on public transport (bus, tram, metro, etc)	Perform - People of all ages to move and dwell
D1	50%	65%	77%	44%	21%	18%	73%	27%	47%	79%	89%	16%	23%	48%	61%	50%	56%	70%	74%	48%	55%	50%	49%	56%	45%	83%	64%	32%	55%	78%	63%	67%
D2	31%	62%	74%	41%	21%	18%	64%	31%	36%	79%	69%	13%	28%	21%	46%	51%	54%	75%	76%	58%	46%	48%	75%	61%	56%	79%	67%	44%	57%	63%	61%	58%
D3	55%	68%	83%	38%	23%	15%	70%	28%	45%	73%	88%	13%	18%	28%	50%	58%	52%	67%	71%	47%	44%	44%	65%	51%	49%	78%	69%	39%	49%	43%	42%	61%
R1	38%	60%	60%	28%	28%	45%	40%	11%	30%	49%	43%	15%	17%	40%	34%	34%	53%	68%	69%	47%	49%	54%	45%	39%	48%	67%	46%	39%	37%	48%	36%	42%
R2	44%	68%	72%	40%	40%	40%	64%	32%	40%	64%	40%	48%	28%	44%	24%	48%	75%	81%	82%	67%	77%	80%	70%	60%	68%	83%	62%	67%	58%	83%	64%	67%
R3	92%	88%	100%	54%	96%	75%	46%	79%	54%	100%	46%	79%	21%	79%	54%	83%	73%	83%	85%	73%	78%	83%	58%	59%	60%	85%	60%	54%	56%	82%	63%	76%
C1	71%	61%	83%	61%	71%	44%	81%	41%	64%	91%	77%	49%	20%	36%	41%	72%	57%	72%	77%	55%	68%	62%	73%	47%	48%	81%	78%	48%	52%	69%	70%	60%
C2	16%	36%	40%	12%	23%	15%	16%	21%	18%	69%	58%	5%	12%	52%	62%	38%	59%	69%	73%	59%	49%	51%	73%	61%	57%	83%	79%	38%	61%	74%	57%	66%
C3	36%	59%	64%	45%	38%	29%	59%	34%	48%	89%	70%	14%	14%	66%	82%	59%	58%	68%	65%	52%	55%	60%	79%	64%	62%	86%	54%	35%	45%	81%	86%	68%
I1	41%	56%	52%	30%	26%	17%	46%	28%	43%	76%	61%	39%	15%	24%	67%	48%	42%	49%	56%	42%	37%	40%	50%	37%	42%	68%	49%	30%	46%	71%	65%	49%
I2	40%	45%	60%	28%	17%	0%	53%	28%	30%	72%	72%	19%	21%	19%	74%	57%	44%	57%	61%	45%	38%	40%	63%	52%	46%	76%	62%	31%	52%	59%	62%	61%
I3	48%	79%	83%	45%	41%	48%	63%	28%	39%	88%	53%	15%	17%	44%	36%	59%	51%	65%	72%	48%	53%	60%	44%	44%	42%	73%	45%	37%	48%	73%	49%	50%
Total	44%	59%	68%	37%	35%	28%	55%	30%	40%	78%	65%	23%	18%	42%	54%	54%	56%	69%	72%	54%	54%	56%	62%	53%	52%	78%	61%	41%	51%	68%	60%	60%

Figure 49: Aggregated response proportions (“Easy” and “Very easy”) for functionality questions comparing the online survey with the field intercept survey

As shown in Figure 49 the heat maps present a close similarity to the outcomes of the field intercept survey, confirm that the functionality needs of the community have been generally met by the street

designs at the 12 case study sites. **Differences between the two surveys are highlighted in pink, where online responses for the sites of Meehan Street (R2), N Steyne and S Steyne (C1) and Peats Ferry Road (C2) had a more moderate perception** for questions related to cycling and exercising (online responses generally found this easy, while field intercept indicated it was more difficult). Participants generally found all 12 sites easy to walk, eat and communicate with others while most respondents found the locations to be difficult for children to play and for a person to work.

4.2.2.2 Perceptions of safety interactions

The online survey incorporated a mode-interaction safety question: "*How safe are streets like the one shown above for (pedestrians / cyclists / motorcyclists / car passengers / car drivers) with regard to interactions with (pedestrians / cyclists / motorcyclists / motor vehicles (cars) / heavy vehicles such as buses or trucks)?*" This question enabled the comparison of perceived safety between users and non-users of different transport modes. For this analysis, the following definitions are applied:

- **Users** of a mode were defined as respondents who reported travelling by that mode "*Occasionally*," "*Sometimes*," "*Frequently*," or "*Daily*"
- **Non-users** were those who indicated "*Rarely*" or "*Never*"

Like the persona analysis in Section 4.2.1.3, this distinction is valuable as it allows assessment of whether lived experience with a particular mode shapes safety perceptions, thereby providing insight into potential gaps between direct users' experiences and broader public attitudes. Table 83 summarises the proportion of respondents who regularly use each transport mode and who perceived the depicted location as 'Safe' or 'Very Safe' in relation to interactions with other modes of travel. Overall, for most user-mode interaction combinations, respondents are indicating that the environments presented are safe. Interestingly, people who cycle (45% of the sample) have the highest proportions of safety approval across all mode interactions (64% or greater). More than 70% of responses by motorcyclists reveal that they feel safe when interacting with pedestrians, cyclists, other motorcyclists and cars. However, the lowest proportion of safety approval is related to the motorcyclists and heavy vehicle interactions (42%). In general, user-mode interactions with heavy vehicles displayed the least safety satisfaction. From a user group perspective, pedestrians had the lowest overall safety satisfaction with values ranging between 44% and 59%, which is an intuitive result given they are a vulnerable user with the slowest average speed.

Table 83: Users' safety perceptions ("Safe" or "Very Safe") by mode interaction.

		Sample Size	*With regards to interactions with:*				
			Pedestrians	Cyclists	Motor-cyclists	Motor Vehicles (cars)	Heavy Vehicles (bus, truck, etc)
How safe are streets for:	**Pedestrians**	1676	N/A	49%	52%	59%	44%
	Cyclists	749	72%	69%	64%	70%	66%
	Motorcyclists	604	74%	74%	72%	75%	42%
	Car passengers	1366	64%	56%	58%	58%	52%
	Car drivers	1492	62%	54%	57%	61%	50%

Table 84 presents the non-user proportions of respondents who perceived that the location presented on the images were either "Safe" or "Very Safe" in the context of mode-to-mode interactions. As each respondent will be a pedestrian in a street environment, there will be zero non-users for this category. Proportions of safety approval reduced across all other non-user mode categories by an average of 30%, indicating that unfamiliarity of using a mode negatively affects the perception of safety associated to interactions with that mode. The only exception to this result was the interaction between motorcyclists and heavy vehicles, where there was an increase the proportion of responses that indicated acceptable safety. Removing this result increases the percentage reduction to more than 34%.

Unfamiliarity of using a mode has been noted as negatively affecting perceptions related to the mode as highlighted in public transport literature (Cascajo et al., 2019) and also in studies in active transport use (Basaran et al., 2021), consistent with the findings observed in the survey.

Table 84: Non-users' safety perceptions ("Safe" or "Very Safe") by mode interaction.

		Sample Size	*With regards to interactions with:*				
			Pedestrians	**Cyclists**	**Motor-cyclists**	**Motor Vehicles (cars)**	**Heavy Vehicles (bus, truck, etc)**
How safe are streets for:	**Pedestrians**	0	N/A	N/A	N/A	N/A	N/A
	Cyclists	927	42%	35%	37%	45%	23%
	Motorcyclists	1072	45%	37%	42%	47%	61%
	Car passengers	310	52%	43%	45%	51%	31%
	Car drivers	184	46%	40%	42%	47%	35%

From a practitioner perspective, these findings **highlight the importance of recognising that safety perceptions are not only shaped by objective design factors but also by personal familiarity with different modes**. Interventions that improve visibility, predictability, and mutual understanding across modes, particularly for vulnerable users and in interactions with heavy vehicles, can therefore help bridge the gap between user and non-user perceptions, supporting safer and more inclusive street environments.

4.2.2.3 Prioritisation of features and safety

The online survey consisted of some different questions as compared with the field intercept survey to satisfy the online medium. Specifically, there were questions were participants had to prioritise street features and safety considerations.

Table 85 presents the aggregated response proportions for the question "*Select the 5 key aspects that most often need improvements in streets like the one shown above"*. Public transport accessibility, cycling infrastructure and street furniture were highlighted as the key aspects that often need improvement for the street types being investigated. Whereas the presence of, and infrastructure related to, motor vehicles is deemed as being less important. Consistent with previous results, participants deem the streets have adequate infrastructure for walking and are generally pleased with the number of pedestrians present as well as the cleanliness and maintenance of the existing infrastructure.

Table 86 describes the aggregated response proportions for the question "*Select the 5 key safety concerns for streets like the one shown above"*. The key area of concern is when people are walking and cycling and interacting with other users, this is evident with more than 40% of the sample rating the associated indicators as a top 5 priority. It is important to also to note that respondents generally did not prioritise safety concerns associated with motorised transport options.

Table 85: Aggregated response proportions for the question, "Select the 5 key aspects that most often need improvements in streets like the one shown above"

Prioritisation	Public transport (bus, tram, train, metro, ferry, etc)	Areas for cyclists (bikes and e-bikes) to ride	Number and/or speed of cyclists (bikes and e-bikes)	Parking areas for cyclists (bikes and e-bikes)	Street furniture (benches, bus stop shelters, garbage bins, etc)	Landscaping (trees, street planters, flower boxes, etc)	Services and amenities (grocery store, coffee shop, etc)	Surrounding buildings (height, aesthetics, etc)	Number and/or speed of motorbikes	Number and/or speed of motor vehicles (cars)	Number and/or speed of heavy vehicles (bus, truck, etc)	Areas for motor vehicles to drive or ride	Areas for pedestrians to walk or dwell	Number of pedestrians	Parking areas for motor vehicles	Designated pedestrians crossings	Signage (traffic lights, speed limits sign, etc)	Environmental comfort (street lighting, air quality, noise, smell, etc)	Cleanliness	Maintenance
1st	22%	9%	6%	5%	9%	5%	3%	2%	3%	4%	3%	2%	8%	1%	6%	5%	3%	2%	2%	2%
2nd	11%	11%	9%	5%	11%	5%	5%	2%	3%	4%	4%	4%	7%	1%	4%	4%	3%	3%	3%	1%
3rd	7%	11%	10%	8%	9%	7%	7%	3%	4%	3%	3%	3%	6%	1%	4%	5%	4%	3%	2%	1%
4th	4%	9%	6%	13%	9%	6%	8%	3%	4%	5%	2%	3%	4%	2%	6%	5%	3%	3%	3%	2%
5th	3%	6%	2%	5%	16%	8%	7%	4%	4%	4%	5%	3%	5%	3%	5%	4%	4%	5%	5%	4%
Totals	46%	46%	34%	36%	55%	31%	30%	13%	17%	21%	17%	14%	30%	8%	24%	23%	16%	16%	14%	10%

Table 86: Aggregated response proportions for the question, "Select the 5 key safety concerns for streets like the one shown above"

Prioritisation	Pedestrian interacting with Cyclists	Pedestrian interacting with Motorcyclists	Pedestrian interacting with Motor vehicles	Cyclist interacting with Pedestrians	Cyclist interacting with other Cyclists	Cyclist interacting with Motorcyclists	Cyclist interacting with Motor vehicles	Car Passenger interacting with Pedestrians	Car Passenger interacting with Cyclists	Car Passenger interacting with Motorcyclists	Car Passenger interacting with Motor vehicles	Car Driver interacting with Pedestrians	Car Driver interacting with Cyclists	Car Driver interacting with Motorcyclists	Car Driver interacting with Motor vehicles	Motorcyclist interacting with Pedestrians	Motorcyclist interacting with other Cyclists	Motorcyclist interacting with other Motorcyclists	Motorcyclist interacting with Motor vehicles
1st	29%	12%	26%	4%	3%	2%	6%	3%	2%	1%	3%	3%	1%	1%	1%	1%	1%	0%	1%
2nd	10%	14%	15%	10%	4%	4%	11%	5%	4%	2%	3%	5%	3%	3%	2%	1%	1%	0%	2%
3rd	7%	10%	14%	11%	6%	5%	10%	4%	4%	2%	4%	4%	5%	2%	3%	2%	2%	2%	5%
4th	4%	6%	5%	13%	9%	7%	9%	5%	5%	4%	5%	5%	4%	3%	4%	3%	2%	1%	5%
5th	3%	2%	3%	6%	11%	8%	6%	6%	5%	5%	6%	6%	5%	3%	8%	5%	5%	3%	7%
Totals	52%	43%	62%	43%	32%	26%	42%	23%	20%	14%	22%	23%	19%	12%	17%	13%	10%	6%	20%

4.2.2.4 Correlation Analysis

The purpose of the correlation analysis for the online survey mirrored that of the intercept survey: to identify whether there are clear relationships between demographic variables, activity engagement and perceptions of safety. Unlike the intercept survey, the online survey also contained variables associated with the prioritisation of improvement for each of the case study locations, as such this was also included in the analysis. The intent was to determine whether simple bivariate correlations could explain variation in perceptions, or whether more complex models were necessary.

As with the intercept survey, all variables were included and examined in a full pairwise matrix. Table 87 summarises the combinations tested with the complete set of coefficients presented in **Appendix E**. Given the nature of the online survey (off-site and can be completed anywhere), the correlation analysis excluded comparisons with objective data collected on-site.

Table 87: Variable combinations considered in correlation analysis of the online survey data

Variable Group 1	Variable Group 2	Example relationships examined
Demographics	Activities (Functionality)	• Age versus Walkability • Income versus Ability to Chat
Demographics	Safety Perceptions	• Age versus Pedestrian Safety • Income versus Driving Safety
Demographics	Safety Priorities	• Age versus Pedestrian Safety Prioritisation • Income versus Cyclist Safety Prioritisation
Demographics	Improvement Priorities	• Age versus Public Transport Improvement Prioritisation • Income versus Street Furniture Improvement Prioritisation
Activities (Functionality)	Activities (Functionality)	• Walkability versus Ability to Chat • Relaxing versus Resting
Activities (Functionality)	Safety Perceptions	• Walkability versus Pedestrian Safety • Ability to Chat versus Driving Safety
Activities (Functionality)	Safety Priorities	• Walkability versus Pedestrian Safety Prioritisation • Ability to Chat versus Cyclist Safety Prioritisation
Activities (Functionality)	Improvement Priorities	• Relaxing versus Public Transport Improvement Prioritisation • Ability to Cycle versus Street Furniture Improvement Prioritisation
Improvement Priorities	Safety Perceptions	• Public Transport Improvement Prioritisation versus Pedestrian Safety Prioritisation • Street Furniture Improvement Prioritisation versus Cyclist Safety Prioritisation
Improvement Priorities	Safety Priorities	• Pedestrian Safety versus Pedestrian Safety Prioritisation • Driving Safety versus Cyclist Safety Prioritisation

Like the results from the intercept survey, most correlations were again weak (*<0.2*), indicating limited direct relationships between the variables considered. A few select relationships reached moderate levels of correlation (*0.3-0.5*), especially between activity participation and safety perceptions, and very few exceed 0.5. These results reaffirm that relationships between variables are influenced by overlapping factors rather than isolated one-to-one relationships.

Table 88 highlights the strongest correlations in the online survey which are generally consistent with the outcomes of the online survey. The trends can be summarised as follows:

- **Mode-related safety perceptions**: Unlike the intercept survey, **correlations between mode used and safety perceptions was weaker**. There were still moderate correlations between cyclists and motorcyclists with safety variables but almost no correlation among car drivers and

passengers. This may be linked to the absence of contextual cues when completing the survey remotely, which can reduce participants' awareness of safety implications since their responses rely on memory rather than direct environmental stimuli. Similar effects have been noted in recent online questionnaires examining travel behaviour during the COVID-19 period (Singh & Sagar, 2021).

- **Activity clusters**: As with the intercept survey results, social and passive behaviours (e.g chatting, relaxing, resting, resting) tended to be positively correlated. In addition, the ease of physical activity variables (exercise, children playing and cycle) are also positively correlated.
- **Safety perception is dependent on the ease of performing activities**: Moderate positive correlations exist between all activity variables and most safety perception variables. Thus, creating environments where everyday activities can be carried out easily reinforces a broader sense of safety (mutually reinforcing aspects). This observation was not present in the intercept survey correlation analysis.
- **Pedestrian area maintenance impacts perceptions of safety**: Consistently negative though weak correlations (varying between -0.13 and -0.25) between the "improve pedestrian area" variable and the safety perception variables suggest that inadequate or poorly maintained walking infrastructure impacts the perceptions of overall safety.

Table 88: Highest observed correlations within the online survey data

Relationship	Correlation	Description
Cycle Use and Safety variables	0.22-0.47	Motorcyclists and cyclists had moderate positive correlations with safety variables.
Motorbike Use and Safety Variables	0.24-0.52	
Relaxing and Resting	0.62	Social and passive behaviours align across the case study locations. Physical activities are also showing positive correlations.
Phone Use and Chatting	0.59	
Rest and Read	0.52	
Children Playing and Read/Rest/Exercise	0.51-0.54	
Exercise and Cycle	0.57	
Cycling Ease versus Safety Perception variables	0.24-0.51	A number of activity variables had moderately strong positive correlations with the mode-specific safety perception responses.
Exercise Ease versus Safety Perception variables	0.20-0.47	
Movement/Dwelling Ease versus Safety Perception variables	0.19-0.48	
Ease of Children Playing versus Safety variables	0.30-0.49	
Improvement to Pedestrian Area and Safety Perception variable	(-0.13) – (-0.25)	Consistently negative correlation between the pedestrian area improvement variable and safety perception variables.

The analysis therefore suggests that perceptions of safety, activity use, and improvement priorities in public space are not driven by any single variable. While activity–safety links and improvement–safety alignment shows stronger associations, most correlations remain weak, pointing to more complex and multifactorial influences. This underscores the value of moving beyond bivariate analysis toward multivariate modelling approaches that can capture indirect and combined effects.

4.2.3 Appropriate Speed Limit Response Assessment

Speed and people's perceptions of speed were focal areas of the research project. Accordingly, a common question across both surveys focussed on participants providing an indication of the appropriate speed:

- Intercept Survey: "*In your opinion, what would be an appropriate speed limit for motor vehicles on the street we are in?*"
- Online Survey: "*In your opinion, what would be an appropriate speed limit for motor vehicles for streets like the one shown above?*"

The results of the intercept survey revealed that **90.3% of respondents felt that the speed limit should be 40 km/h or less** across all 12 sites, with 59% suggesting it should be 30 km/h or lower. This is notable given that the posted speed limits across the surveyed sites ranged from 10 km/h (e.g. Chisholm Street, Darlinghurst) to 50 km/h (e.g. Peats Ferry Road, Hornsby). For most sites with posted speed limits of 40 km/h or higher, most respondents recommended lower limits (highlighted in pink), exceptions included Peats Ferry Road and Henderson Road, where perceptions were more aligned with existing speeds. Table 89 presents the distribution of responses.

Table 89: Distribution of responses for the "appropriate speed" question within the intercept survey.

	Total Samples	Posted Speed (km/h)	10km/h	20km/h	30km/h	40km/h	50km/h	60km/h	Other	% Below Posted Speed
Albert Street (D1)	62	**40**	8.1%	16.1%	43.5%	29.0%	1.6%	0.0%	1.6%	**67.7%**
Main Street (D2)	39	**40**	23.1%	25.6%	20.5%	20.5%	2.6%	7.7%	0.0%	**69.2%**
Bankstown City Plaza (D3)	40	**10**	27.5%	25.0%	25.0%	20.0%	2.5%	0.0%	0.0%	-
Chisholm Street (R1)	47	**10**	59.6%	19.1%	12.8%	6.4%	0.0%	0.0%	2.1%	-
Meehan Street (R2)	25	**50**	4.0%	12.0%	32.0%	40.0%	12.0%	0.0%	0.0%	**88.0%**
Private Street (R3)	24	**10**	12.5%	25.0%	20.8%	33.3%	8.3%	0.0%	0.0%	-
N/S Steyne (C1)	75	**30**	6.7%	17.3%	45.3%	26.7%	4.0%	0.0%	0.0%	**24.0%**
Peats Ferry Road (C2)	97	**40**	2.1%	10.3%	13.4%	54.6%	17.5%	2.1%	0.0%	**25.8%**
Henderson Road (C3)	56	**40**	7.1%	10.7%	17.9%	50.0%	8.9%	5.4%	0.0%	**35.7%**
Esplanade / Belgrave (I1)	54	**30**	1.9%	14.8%	46.3%	22.2%	7.4%	5.6%	1.9%	**16.7%**
Anderson / Victoria (I2)	47	**40**	8.5%	10.6%	34.0%	42.6%	2.1%	0.0%	2.1%	**53.2%**
Portman /Merton (I3)	75	**40**	30.7%	21.3%	18.7%	17.3%	5.3%	0.0%	6.7%	**70.7%**
Total	641		**15.0%**	**16.5%**	**27.5%**	**31.4%**	**6.6%**	**1.7%**	**1.4%**	

As shown in Table 90, the online survey revealed similar results, where **81.7% of respondents felt that the speed limit should be 40km/h or less** across all 12 sites, with 51.9% suggesting 30km/h or lower. However, there is a notable difference for Meehan Street (R2), the only site with a posted speed limit greater than 40km/h, where most of the online responses indicated a speed limit of 50km/h was suitable contradicting the results from the small sample size evaluation within the intercept survey. Consistent with the intercept survey is the majority proportion of responses recommending lower speed limits which was observed in six out of the nine sites (highlighted in pink). It is also important to note that the majority proportions are less in the online survey (ranging from 50.8% to 61.6%) as compared with the intercept survey (53.2% to 88%).

Table 90: Distribution of responses for the "appropriate speed" question within the online survey.

	Total Samples	Posted Speed (km/h)	10km/h	20km/h	30km/h	40km/h	50km/h	60km/h	Other	% Below Posted Speed
Albert Street (D1)	128	40	7.0%	16.4%	27.3%	31.3%	16.4%	1.6%	0.0%	**50.8%**
Main Street (D2)	153	40	8.5%	19.6%	25.5%	34.0%	11.1%	1.3%	0.0%	**53.6%**
Bankstown City Plaza (D3)	142	10	28.9%	30.3%	16.2%	15.5%	8.5%	0.7%	0.0%	-
Chisholm Street (R1)	145	10	29.7%	22.8%	20.0%	17.9%	6.2%	2.8%	0.7%	-
Meehan Street (R2)	132	50	2.3%	5.3%	21.2%	26.5%	39.4%	5.3%	0.0%	**55.3%**
Private Street (R3)	143	10	5.6%	7.7%	22.4%	39.2%	22.4%	2.8%	0.0%	-
N/S Steyne (C1)	141	30	14.9%	19.1%	27.0%	25.5%	9.9%	3.5%	0.0%	**34.0%**
Peats Ferry Road (C2)	134	40	6.7%	19.4%	24.6%	32.8%	15.7%	0.7%	0.0%	**50.7%**
Henderson Road (C3)	139	40	2.9%	12.9%	23.7%	40.3%	19.4%	0.7%	0.0%	**39.6%**
Esplanade / Belgrave (I1)	142	30	3.5%	7.0%	22.5%	40.8%	22.5%	3.5%	0.0%	**10.6%**
Anderson / Victoria (I2)	138	40	16.7%	19.6%	25.4%	24.6%	12.3%	1.4%	0.0%	**61.6%**
Portman /Merton (I3)	139	40	12.2%	25.2%	20.9%	28.8%	12.9%	0.0%	0.0%	**58.3%**
Total	1676		**11.7%**	**17.2%**	**23.0%**	**29.8%**	**16.2%**	**2.0%**	**0.1%**	

To add further to this discussion, Table 91 compares posted speed limits with observed speeds at key locations in each case study, alongside the subjective "appropriate speed" responses.

Table 91: Comparison of observed speed metrics and the responses to the "appropriate speed" question in the intercept and online surveys across the twelve case study sites.

	Posted Speed Limit (PSL)	Observed Average Speed		Observed 85th Percentile Speed		% Subjective responses below posted speed limit	
		Value (km/h)	% Difference from PSL	Value (km/h)	% Difference from PSL	Intercept Survey	Online Survey
Albert Street (D1)	40	22.4	-44.00%	28.1	-29.75%	67.7%	50.8%
Main Street (D2)	40	14.5	-63.75%	20.2	-49.50%	69.2%	53.6%
Bankstown City Plaza (D3)	10	14.5	45.00%	20.6	106.00%	-	-
Chisholm Street (R1)	10	12.7	27.00%	16.7	67.00%	-	-
Meehan Street (R2)	50	36.6	-26.80%	44.2	-11.60%	88.0%	55.3%
Private Street (R3)	10	23.0	130.00%	28.9	189.00%	-	-
N/S Steyne (C1)	30	22.2	-26.00%	27.6	-8.00%	24.0%	34.0%
Peats Ferry Road (C2)	40	28.6	-28.50%	35.3	-11.75%	25.8%	50.7%
Henderson Road (C3)	40	31.1	-22.25%	38.0	-5.00%	35.7%	39.6%
Esplanade / Belgrave (I1)	30	26.2	-12.67%	34.1	13.67%	16.7%	10.6%
Anderson / Victoria (I2)	40	20.6	-48.50%	26.6	-33.50%	53.2%	61.6%
Portman /Merton (I3)	40	23.1	-42.25%	28.6	-28.50%	70.7%	58.3%

Highlighted in green are instances where the observed speed metric is less than the posted speed limit or where a majority of survey respondents selected an appropriate speed lower than the posted speed

limit. Shaded in pink are instances where the observed speed metric is greater than the posted speed limit. In cases where multiple measurement points existed (see Section 4.1), simple arithmetic averages were calculated to provide representative observed speeds for each location. The results show that in 75% of case study sites, average speeds were at least 12% below the posted speed limit. For the 85th percentile speed metric, 67% of the case studies were at least 5% below the limit. A clear exception to this pattern was the 10km/h shared zones where both average and 85th percentile speeds exceeded the posted limit significantly, indicating non-compliance. This result for shared zones is consistent with the results presented in the macroscopic analysis of all streets across the Greater Sydney (see Section 3.4). This objective tendency to drive below posted speed limits is mirrored in the subjective data, where most respondents across both the intercept and online survey indicated that the appropriate speed limit should be less than the posted limits. While these results demonstrate a strong alignment between subjective perceptions and revealed driving behaviour, they are based on a limited sample of 12 case study sites. Further research across a larger dataset would be needed to confirm the broader generalisability of these patterns.

The convergence of revealed and subjective data provides evidence in support of reconsidering local road speed limits. Whereas previous experimental studies using photographs of streets found that participants often preferred speeds above the posted limit (Ambros et al. (2021) and Goldenbeld and van Schagen (2007)), the present findings demonstrate the opposite. Both observed driving behaviour and pedestrian perceptions favour lower speeds in most local street contexts. This contrast may partly reflect the lower-speed environments examined in this project, but also the method of intercept surveys, which captured perception from participants directly experiencing the street as pedestrians, thereby reducing abstraction and incorporating user role effects. **Taken together, these findings diverge from past research and highlight a novel contribution by demonstrating how context and user role can shape perceptions of appropriate speed.** At the same time, the shared zone stands out as critical exceptions where compliance remains poor, pointing to the need for further investigation into how design, enforcement, and user behaviour interact in these settings.

It is important to note that recent literature emphasises **the growing emphasis of lower speed environments, and the results obtained in this study, suggests that communities may be increasingly accepting of such changes**. Yannis and Michelaraki (2025) conducted a comprehensive review of case study literature concerning the effectiveness of 30km/h speed limits on roads. The research found that the policy reduced road fatalities by 40% while also having significant positive impacts on the environment and public health through reduced fuel consumption and increased walking and cycling (Yannis & Michelaraki, 2025). Recent case study evaluations undertaken in the United Kingdom (Scotland, Ireland and Wales) have reported significant reductions in fatalities and improvements in road safety (Milton et al., 2021) or reductions in speed and vehicle volumes (Nightingale et al., 2021). van Erpecum et al. (2024) similarly highlighted positive public health impacts, while also noting methodological challenges in evaluating these initiatives due to their trial-based nature and localised implementations. Pearson et al. (2025) identified this limitation as a key barrier to strategic adoption in Australia; however, the *NSW Speed Zoning Standard* and Guide to Road Safety (Part 3: Safe Speed) provide a foundation through the inclusion of the “High Pedestrian Activity Area (HPAA)” definition that promotes 20km/h to 40km/h posted speed limits. Karndacharuk and McTiernan (2019) also presented a set of “implementation principles” for 30km/h speed limits and zones consolidated through a widespread practitioner engagement process, offering guidance for more systematic application. Collectively, this body of evidence indicates growing international and local support for lower speed environments as a fundamental step toward safer, healthier, and more inclusive street networks.

4.3 Statistical Modelling for Perceived Safety Assessment

Understanding how people perceive safety in shared spaces is central to evaluating their effectiveness. Survey respondents in both the intercept and online surveys were asked to rate safety using ordered categories (e.g. very safe, safe, neutral, unsafe, very unsafe). These outcomes are inherently ranked, but the distances between categories are not equal. Traditional regression methods that assume continuous or binary outcomes are therefore unsuitable. Behind each response, the model assumes there is an unobserved latent '**perceived safety score**' in a respondent's mind, and the chose category simply reflects which range (or threshold) that unobserved score falls into. To account for this ordered but non-linear structure, **Ordinal Logistic Regression (OLR) was used**. OLR models the cumulative probability that a respondent's perception falls at or below a certain safety level, conditional on explanatory (independent) variables such as demographics or suitability of certain street design features. The general structure of the OLR model is:

$$ln\left(\frac{P(Y \leq j)}{P(Y > j)}\right) = \theta_j - \beta_1 X_1 - \beta_2 X_2 - \ \ldots - \beta_k X_k \tag{2}$$

Y = ordinal response variable (perceived safety)

j = threshold index (1 to 3 for four categories)

θ_j= threshold (or intercept) for the "j^{th}" category

$\beta_1, \beta_2, \ldots, \beta_k$ = coefficients of independent variables

$X_1, X_2, \ldots, X_k$ = independent variables (participant responses to other question)

This formulation is equivalent to assuming that each respondent has a latent continuous utility variable (perceived safety score) U_i:

$$U_i = \beta_1 X_{i1} + \beta_2 X_{i2} + \ \ldots + \beta_k X_{ik} + \varepsilon_i \tag{3}$$

Where X_{ik} = the observation of that variable for a particular respondent i and the error term ε_i follows a logistic distribution. The observed outcome Y_i is determined by where the hidden safety score U_i falls relative to the threshold values θ_j:

$$Y_i = \begin{cases} 0 & \text{if} \quad U_i \leq \theta_1 \\ 1 & \text{if} \quad \theta_1 < U_i \leq \theta_2 \\ & \ldots \\ j & \text{if} \quad U_j > \theta_j \end{cases} \tag{4}$$

The probability of falling into category "j" is obtained by subtracting cumulative probabilities:

$$P(Y = j) = P(Y \leq j) - P(Y \leq j - 1) \tag{5}$$

Given the logistic distribution of the error term, Equation (5) can be expanded to the following:

$$P(Y \leq j) = \frac{1}{1 + \exp(\theta_{j-1} - \alpha - \beta_1 X_1 - \cdots - \beta_K X_K)} \tag{6}$$

$$P(Y = j) = \frac{1}{1 + \exp(\theta_{j-1} - \alpha - \beta_1 X_1 - \cdots - \beta_K X_K)} - \frac{1}{1 + \exp(\theta_j - \alpha - \beta_1 X_1 - \cdots - \beta_K X_K)} \tag{7}$$

This formulation allows explanatory variables (e.g. the presence of street furniture, areas for bicycle parking) to shift the probability distribution across the ordered categories. For example, an increase in street furniture reduces the probability of respondents choosing "unsafe" and increases the probability of choosing "safe" or "very safe".

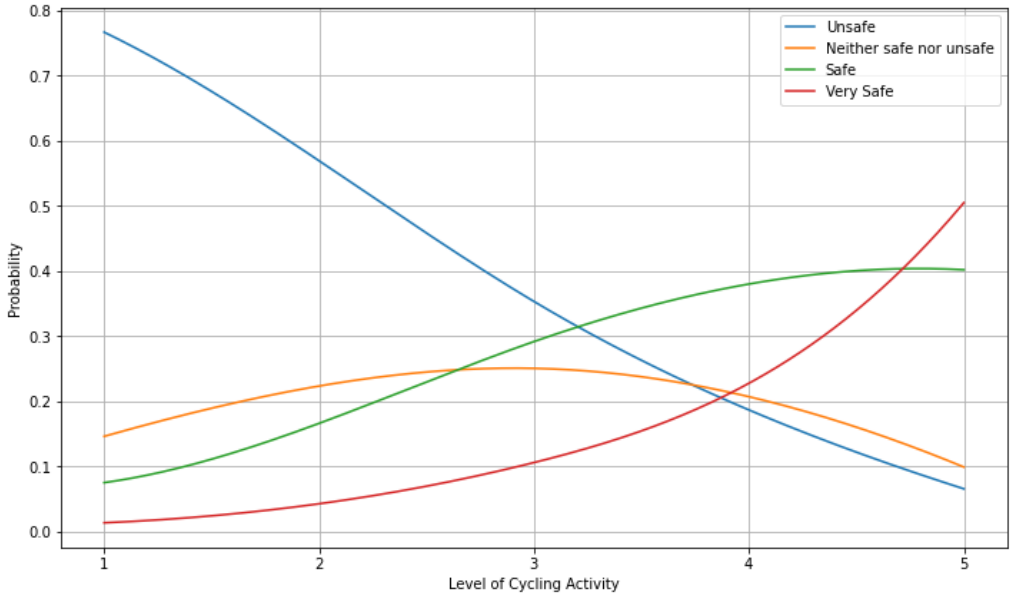


Figure 50: Illustration of probability curves from an OLR, highlighting how changes to an independent variable impact the perception of safety

Figure 50 illustrates how the mathematical formulation of the OLR translates into practice. The curves presented describe the change in safety perceptions as the average level of cycling activity becomes easier to perform on a street (1 = very hard to perform, 5 = very easy to perform). The curves show the probability of each safety response category ("Unsafe", "Neutral", "Safe", "Very Safe") as function of an independent variable. Assuming all other variables stay constant, as it becomes easier to cycle on the street the probability mass shifts away from the lower categories and toward the higher safety ratings. **For practitioners, this means that the model not only identifies which factors significantly influence perceptions of safety but also quantifies how incremental improvements in design features alter the likelihood of a street being perceived as safe, providing a direct link between statistical outputs and practical design decisions**.

Leveraging the general structure of the OLR, specific models were estimated considering the objective and subjective data collected throughout the project. The following sub-sections provide details of the model estimation considering the intercept survey data and then online survey data.

4.3.1 Community Safety Perceptions from Intercept Survey

An ordered logit model was estimated using the intercept (face-to-face) survey dataset, with the dependent variable being the response to the "Overall Safety Assessment" question.

"***Overall, I think the street we are currently standing on is...***

- *Very unsafe for the community*
- *Unsafe for the community*
- *Neither safe nor unsafe for the community*
- *Safe for the community*
- *Very safe for the community*"

This question captured the respondent's general perception of community safety in the observed street environment. To improve statistical reliability, the original five-point scale was collapsed into four categories: "very unsafe" and "unsafe" were combined into a single group, while "I don't know" responses were excluded, consistent with the formulation presented in Equation (1). This ensured that the model outputs reflected meaningful and consistent safety perceptions.

Table 92: Ordinal scale reference table for dependent variable responses

Ordinal Scale	Dependent Variable Responses
1	Very unsafe and Unsafe
2	Neither unsafe nor safe
3	Safe
4	Very safe

4.3.1.1 Data Preparation and Variables

Categorical demographic variables were consolidated to reduce sparsity in the data. This process helped to reduce noise and improved the statistical power of each group considered in the model (Powers & Xie, 2008). Age was grouped into three categories: 18–34 years (Young Adults), 35–54 years (Midlife Adults), and 55–74 years (Older Adults). Income was similarly grouped into low ($45,000 or less), medium ($45,001–$135,000), and high ($135,001 or more).

Furthermore, other independent variables covered a wider range of street design and user-experience attributes gathered from the survey. **Appendix F** presents a detailed table of the definition of each variable considered. The following provides an overall summary of the input variables considered:

- **Demographics**: age, income and gender
- **Performing activities (activity-based variables)**: perceived ease of walking, relaxing, exercising, resting, and driving a car on the street.
- **Safety dimensions**: pedestrian safety in relation to crime and in relation to motor vehicles.
- **Street suitability**: cleanliness, maintenance, pedestrian crossings, environmental comfort, suitability of pedestrian areas, and perceived impact of motor vehicle volume/speed.
- **Objective conditions**: measured pedestrian volume, traffic volume, and average vehicle speed at the time of survey completion.
- **Speed preferences**: respondents' views on the appropriate vehicle speed limit for the street (10–60 km/h).

The activity/functionality and suitability variables relate to the Likert questions of the survey where participants provided categorical responses. These categories were mapped to an ordinal scale as presented in Table 93.

Table 93: Ordinal scale referencing for independent variable responses

Ordinal Scale	Independent variable responses for		
	Activity/Functionality questions	**Suitability questions**	**Safety questions**
0	I don't know	I don't know	I don't know
1	Very hard to perform	Very unsuitable	Very unsafe
2	Hard to perform	Unsuitable	Unsafe
3	Neither hard nor easy	Neither unsuitable nor suitable	Neither unsafe nor safe
4	Easy to perform	Suitable	Safe
5	Very easy to perform	Very suitable	Very safe

Two versions of the OLR model were developed: one using the **non-normalised dataset** (raw values for traffic, pedestrian volumes, and other continuous inputs), and another using a **normalised dataset** where all inputs were scaled between 0 and 1. Normalisation was undertaken to account for the very different ranges of input variables (e.g. pedestrian volume up to 3,314 vs. binary demographic indicators). The following sub-sections provide details of the model findings

4.3.1.2 Non-normalised OLR Model Findings

Table 94 presents the estimation results for the non-normalised model. This initial model indicated several significant relationships across demographic, activity-based, and environmental variables.

Significant variables are identified based on the p-value associated with the coefficient of a particular variable of parameter in the model. A **p-value below 0.05 indicates that there is strong statistical evidence** (at the 95% confidence level) that the variable has a meaningful effect on the dependent variable, in this case perceived safety. **Highlighted in green are the p-values of all significant variables that influence perceived safety, the purple-coloured cells indicate a significant variable considering a 90% confidence interval while the other key variables (shared in red) are ones which were expected to influence perceived safety but were not significant.**

Table 94: Non-normalised OLR model estimation results

Variables and Parameters	Coefficient Value	Std error	p-value
Constant (Class 0)	-5.8227	0.3381	0.0000
Demographic Variables			
Age_2 (35 - 54 years)	0.4856	0.2167	0.0250
Age_3 (55 - 74 years)	0.4509	0.2268	0.0468
Gender	0.2060	0.1825	0.2591
Income_2 ($45,001 - $135,000)	-0.0021	0.2439	0.9933
Income_3 (>$135,000)	0.5092	0.2111	0.0159
Objective Data Variables			
Pedestrian Volume	0.0000	0.0001	0.7667
Average Speed	-0.0440	0.0981	0.6541
Traffic Volume	-0.0001	0.0003	0.5900
Activity Performance Variables			
Perform - Drive	-0.1639	0.0767	0.0326
Perform - Exercise	0.2193	0.0774	0.0046
Perform - Relax	0.1874	0.0953	0.0492
Perform - Walk	0.4188	0.1281	0.0011
Pedestrian Safety (crime)	0.2758	0.0549	0.0000
Pedestrian Safety (motor vehicles)	0.6236	0.1191	0.0000
Appropriate Speed (Choice)	0.0590	0.0964	0.5402
Design and Suitability Variables			
Suitability - Cleanliness	0.1607	0.0967	0.0966
Suitability - Designated pedestrians crossings	0.1899	0.0980	0.0526
Suitability - Environmental comfort	0.2159	0.1056	0.0410
Suitability - Maintenance	0.3157	0.0942	0.0008
Suitability - Number and/or speed of motor vehicles	0.1729	0.0895	0.0533
Suitability - Areas for pedestrians to walk or dwell	0.2822	0.1216	0.0203

For **demographic variables**, age and income were both influential. Respondents aged 35–54 (*0.486, $p = 0.025$*) and 55–74 (*0.451, $p = 0.047$*) were significantly more likely to perceive their community as safe compared with the youngest age group (18–34). Higher-income respondents (*0.509, $p = 0.016$*) also reported higher safety perceptions. In contrast, gender (*$p = 0.259$*) and medium income (*$p = 0.993$*) were not statistically significant, suggesting these characteristics did not strongly influence reported safety levels.

The **activity-based variables** revealed some of the strongest relationships. Walking showed the most pronounced positive association with perceived safety (*0.419, $p = 0.001$*), reinforcing the central importance of walkability in shaping community safety. Exercising (*0.219, $p = 0.005$*) and relaxing (*0.187, $p = 0.049$*) were also significant and positive, indicating that streets which comfortably support a range of activities are viewed as safer. In contrast, driving was negatively associated with safety (*–0.164, $p = 0.033$*), suggesting that environments designed to facilitate car use may reduce pedestrian confidence and undermine perceptions of safety.

Turning to **street design and environmental attributes**, several variables were statistically significant. Maintenance was a strong positive predictor (*0.316, $p < 0.001$*), highlighting the importance of well-kept infrastructure in fostering perceptions of safety. Environmental comfort also had a significant positive

effect (*0.216, p = 0.041*), suggesting that factors such as lighting, air quality, and noise shape safety perceptions in meaningful ways. Similarly, suitability of pedestrian areas was significant (*0.282, p = 0.020*), pointing to the importance of adequate space for walking and dwelling. Pedestrian crossings (*0.190, p = 0.053*) and suitability with respect to motor vehicle numbers and speeds (*0.173, p = 0.053*) were only marginally significant at the 6% level, while cleanliness was positive but not significant (*0.161, p = 0.097*).

Broader **safety perceptions** were also highly influential. Perceived pedestrian safety in relation to crime (*0.276, p < 0.001*) and in relation to motor vehicles (*0.624, p < 0.001)* were both strong positive predictors of overall community safety. This finding reinforces that people's evaluations of street environments are not limited to physical design but are also shaped by their sense of security and risk in relation to traffic and antisocial behaviour.

Finally, the **objective traffic measures**, pedestrian volume (*p = 0.767*), traffic volume (*p = 0.590*), and average vehicle speed (*p = 0.654*), were **not statistically significant**. Despite this, their coefficient signs were consistent with theoretical expectations: pedestrian presence appeared to improve perceived safety, while higher traffic volumes and speeds detracted from it. These trends, though not significant in this dataset, are consistent with broader literature on street safety.

Overall, the non-normalised model demonstrates that:

- Older and higher-income respondents reported higher safety perceptions.
- Walking was the single strongest activity-related predictor of safety, with exercising and relaxing also important.
- Well-maintained, comfortable, and pedestrian-friendly streets significantly increased perceived safety.
- Streets that were easier to drive on were perceived as less safe for pedestrians.
- Broader perceptions of safety in relation to crime and motor vehicles strongly reinforced overall safety assessments.
- Objective traffic measures did not reach statistical significance but showed trends consistent with theory.

4.3.1.3 Normalised OLR Model Findings

To account for large differences in variable ranges (e.g. pedestrian counts in the thousands vs. binary demographic indicators), a second model was estimated with all variables normalised to a 0–1 scale. Table 95 presents the results of the normalised OLR model. While the significance of predictors was largely unchanged, normalisation clarified the relative magnitude of effects, highlighting which factors had the strongest influence. The **activity-based variables** emerged as the key predictors in the normalised specification. The ease and ability to walk on a street had by far the largest effect (*2.094, p = 0.001*), more than double the size of other coefficients, confirming its central importance to perceived safety. Exercising (*1.096, p = 0.005*) and relaxing (*0.937, p = 0.049*) were also strongly positive, while driving retained its negative association (*–0.820, p = 0.033*). These results emphasise that environments supporting "people focussed activity" are the most powerful determinants of safety, and that vehicle-oriented environments diminish pedestrian perceptions of safety.

Environmental and design-related variables also showed strong effects after normalisation. Maintenance was a key predictor (*1.579, p < 0.001*), followed by suitability of pedestrian areas (*1.411, p = 0.020*) and environmental comfort (*1.080, p = 0.041*). Pedestrian crossings (*0.950, p = 0.053*) remained marginally significant, while cleanliness (*0.803, p = 0.097*) retained a weak positive influence. These findings reinforce the role of good upkeep and inclusive design in shaping safe, usable streets.

Broader safety perceptions were again among the most influential variables. Perceived safety in relation to motor vehicles (*3.118, p < 0.001*) and crime (*1.379, p < 0.001*) had very large positive coefficients,

confirming that respondents' overall feelings of security are deeply shaped by both traffic conditions and social safety.

For demographic characteristics, the effects remained consistent with the non-normalised model. Older respondents (*midlife and older adults)* and those with higher incomes (*$135,000 or more*) were more likely to report safety, while gender and medium income remained non-significant. Objective measures (pedestrian volume, traffic volume, and average speed) continued to be non-significant, but coefficients retained the same positive/negative directional trends.

Table 95: Normalised OLR model estimation results.

Variables and Parameters	Coefficient Value	Std error	p-value
Constant (Class 0)	-5.8526	0.3393	0.0000
Demographic Variables			
Age_2 (35 54 years)	0.4856	0.2167	0.0250
Age_3 (55 – 74 years)	0.4509	0.2268	0.0468
Gender	0.2060	0.1825	0.2591
Income_2 ($45,001 - $135,000)	-0.0021	0.2439	0.9933
Income_3 (>$135,000)	0.5092	0.2111	0.0159
Objective Data Variables			
Pedestrian Volume	0.1157	0.3899	0.7667
Average Speed	-2.6383	5.8884	0.6541
Traffic Volume	-0.1837	0.3409	0.5900
Activity Performance Variables			
Perform - Drive	-0.8197	0.3836	0.0326
Perform - Exercise	1.0964	0.3871	0.0046
Perform - Relax	0.9368	0.4764	0.0492
Perform - Walk	2.0939	0.6407	0.0011
Pedestrian Safety (Crime)	1.3789	0.2745	0.0000
Pedestrian safety (motor vehicles)	3.1179	0.5954	0.0000
Appropriate Speed (Choice)	3.6020	5.8805	0.5402
Design and Suitability Variables			
Suitability - Cleanliness	0.8033	0.4835	0.0966
Suitability - Designated pedestrians crossings	0.9497	0.4900	0.0526
Suitability - Environmental comfort	1.0795	0.5281	0.0410
Suitability - Maintenance	1.5786	0.4708	0.0008
Suitability - Number and/or speed of motor vehicles	0.8644	0.4473	0.0533
Suitability - Areas for pedestrians to walk or dwell	1.4111	0.6081	0.0203

4.3.1.4 Model Performance

Ordered logit models were developed to assess overall pedestrian safety using the face-to-face survey dataset. While both non-normalised and normalised specifications were estimated to check robustness, they produced identical performance statistics. Results are therefore reported here once only.

Model performance was assessed using an **80% in-sample training set** and a **20% out-of-sample validation set**, with evaluation criteria including log-likelihood, prediction accuracy, and the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The results are summarised in Table 96.

Table 96: Goodness of fit results for the estimated OLR models

Datasets	Loglikelihood	Accuracy	AIC	BIC
In-Sample	-402.69	0.67	855.38	960.29
Out-Sample	-104.32	0.64	258.65	363.56

The in-sample accuracy of **0.67** shows that the model correctly predicts the safety perception category for around two-thirds of respondents, which is a **strong result for an ordinal specification**. Out-of-

sample accuracy of **0.64** demonstrates a modest and expected reduction in predictive strength when applied to unseen data, indicating that the model generalises well. The log-likelihood values (*–402.69* in-sample and *–104.32* out-of-sample) are consistent with the accuracy results, confirming a stable fit across datasets. The AIC and BIC values indicate that the model achieves a good balance between explanatory power and parsimony, supporting the reliability of the estimated relationships.

4.3.1.5 Key Insights

Synthesising the results from both the non-normalised and normalised specifications, several consistent themes emerge:

- **Demographic influences**: Older respondents (35–54 and 55–74) and those with higher household incomes (> $135k) consistently reported higher safety perceptions. Gender and medium-income groups did not have a statistically significant effect.
- **Activity-based effects**: Walking was the strongest predictor of safety in both models, with exercising and relaxing also significant. Driving was negatively associated with safety, showing that environments perceived as car-oriented undermine pedestrian confidence.
- **Street design and maintenance**: Well-maintained streets, good environmental comfort (lighting, air quality, noise), and suitable pedestrian areas strongly improved safety perceptions. Pedestrian crossings and vehicle suitability were marginally significant, while cleanliness was positive but not robust.
- **Perceptions of security**: Respondents' sense of pedestrian safety in relation to both crime and motor vehicles was highly significant, reinforcing that personal security and traffic safety are fundamental to overall safety evaluations.
- **Objective traffic measures**: Pedestrian and traffic volumes, along with average vehicle speed, were not significant, though their directional effects aligned with expectations. Pedestrian presence improved safety, while traffic intensity and speed detracted from it.
- **Relative strength of variables**: The normalised model clarified that activity support (especially walking) and perceptions of security (crime and motor vehicle interactions) exerted the strongest influence overall, with street maintenance and comfort also highly influential.

The face-to-face survey highlighted the broad factors that underpin how safe people feel in shared spaces, such as age, income, walkability, and street maintenance. To complement this, the online survey provides a more detailed view by examining how pedestrians perceive safety when interacting with different types of road users. This allows us to identify mode-specific issues that practitioners can target when planning and designing safer streets.

4.3.2 Mode-specific Safety Perceptions from Online Survey

The online survey was designed to explore a wider set of issues around how people use, and experience streets compared with the intercept survey. It asked respondents to reflect on the ease of performing different activities, the suitability of street conditions, and the features most in need of improvement. Within this broader framework, one key question provided a direct measure of pedestrian safety perception:

"How safe are streets like the one shown above for pedestrians with regard to interactions with…". (Four categories of interaction were considered)

- *Cyclists (bikes and e-bikes)*
- *Motorcyclists*
- *Cars*
- *Heavy vehicles (buses, trucks, etc.)*

These four dependent variables represent distinct but related dimensions of pedestrian safety. Accordingly, four separate OLR models were estimated, one for each interaction type. To ensure

comparability, the same modelling framework was applied across all four. Responses marked as *"I don't know"* were excluded, and "very unsafe" was merged with "unsafe" due to low counts, resulting in a 4-point outcome scale.

4.3.2.1 Data Preparation and Variables

To ensure meaningful analysis, a structured data preparation process was applied consistent. Identical to the intercept survey, demographic variables (age, income, occupation, gender) were consolidated into broader groups to avoid sparsity and activity-based responses (e.g. ease of walking, relaxing, cycling, driving, playing, working) were mapped to ordinal scales. Unlike the intercept survey, the online survey did not contain questions related to suitability of street infrastructure but instead focussed on the prioritisation of areas of improvement based on the images displayed in the survey. As with the other categorical variables, these were mapped to an ordinal scale based on order of priority (5 for highest priority and 1 for the least important priority).

Two broad groups of explanatory variables were particularly important in the definition of the models:

- **Activity performance**: As with the intercept survey, the responses to functional activity-based questions served as key independent variables for the model. These reflected lived experience and engagement with the street.
- **Improvement identification and prioritisation**: Respondents initially identified and then ranked up to five street features that most needed improvement (e.g. signage, crossings, street furniture, environmental comfort). As these were two separate but consecutive questions in the survey, a high correlation was found between the "Improvement Identification" variables and the "Improvement Prioritisation" variables (correlations >0.7, see Table 97). **To avoid multicollinearity, only the "Improvement Prioritisation" indicators were retained** (second column in Table 97), **as they provide richer information about user-identified deficiencies**.

Table 97: Correlations between a variable being identified "improvement identification" variables and "improvement prioritisation" variables

Improvement Identification Variables	Improvement Prioritisation Variables	Correlation
Improve_PublicTransport	ImprovementPriority_PublicTransport	0.917
Improve_CyclingArea	ImprovementPriority_CyclingArea	0.867
Improve_NumberCyclist	ImprovementPriority_NumberCyclist	0.924
Improve_CyclistParking	ImprovementPriority_CyclistParking	0.869
Improve_StreetFurniture	ImprovementPriority__StreetFurniture	0.748
Improve_Landscaping	ImprovementPriority__Landscaping	0.857
Improve_Services	ImprovementPriority__Services	0.874
Improve_Building	ImprovementPriority__Building	0.860
Improve_NumberMotor	ImprovementPriority__NumberMotor	0.871
Improve_NumberCar	ImprovementPriority__NumberCar	0.864
Improve_NumberHvyCar	ImprovementPriority__NumberHvyCar	0.857
Improve_CarArea	ImprovementPriority__CarArea	0.895
Improve_PedestrianArea	ImprovementPriority__PedestrianArea	0.895
Improve_NumberPedestrian	ImprovementPriority__NumberPedestrian	0.859
Improve_CarParking	ImprovementPriority__CarParking	0.883
Improve_PedestrianCrossing	ImprovementPriority__PedestrianCrossing	0.882
Improve_Signage	ImprovementPriority__Signage	0.904
Improve_Environment	ImprovementPriority__Environment	0.868
Improve_Cleanliness	ImprovementPriority__Cleanliness	0.876
Improve_Maintenance	ImprovementPriority__Maintenance	0.833

A full mapping of variables is included in **Appendix F**, consistent with the approach used for the intercept survey models. The following sub-sections present the model estimation results for all mode-specific interaction models. It is important to note that the estimation results presented omit insignificant variables outside of key demographic variables such as gender and occupation.

4.3.2.2 Cyclist Interaction Model

Results for the cyclist interaction model are summarised in Table 98.

Table 98: Cyclist interaction OLR model estimation results

Independent Variables	Coefficient Value	Standard Error	p-value
Demographic Variables			
Midlife adults (35 to 54 years)	0.8754	0.1429	0.0000
Older adults (55 to 74 years)	0.8133	0.1647	0.0000
Women	-0.0714	0.1283	0.5776
Medium income ($45,001 to $135,000)	1.1838	0.1536	0.0000
High income ($135,001 or more)	1.2015	0.1507	0.0000
Not employed or not self-employed	-0.0598	0.1693	0.7238
Activity Variables			
Cycle	0.3057	0.0622	0.0000
Move, Dwell (Disability)	0.1336	0.0699	0.0558
Drive Car	0.2267	0.0722	0.0017
Kid Play	0.2107	0.0604	0.0005
Move, Dwell (All Ages)	0.3811	0.0824	0.0000
Read	0.1320	0.0670	0.0489
Relax	0.2722	0.0692	0.0001
Work	0.1474	0.0606	0.0149
Improvement Variables			
Areas for cyclists to ride	-0.4514	0.0371	0.0000
Parking areas for cyclists	-0.4656	0.0445	0.0000
Number and/or speed of cyclists	-0.4110	0.0437	0.0000
Public Transport	-0.5243	0.0341	0.0000
Surrounding Buildings	-0.4685	0.0641	0.0000
Areas for motor vehicles to ride	-0.4881	0.0574	0.0000
Parking areas for motor vehicles	-0.5372	0.0465	0.0000
Cleanliness	-0.5642	0.0603	0.0000
Environmental comfort	-0.4913	0.0553	0.0000
Landscaping	-0.4731	0.0427	0.0000
Maintenance	-0.3531	0.0696	0.0000
Number and/or speed of motor vehicles	-0.5932	0.0496	0.0000
Number and/or speed of heavy vehicles	-0.5338	0.0560	0.0000
Number and/or speed of motorbikes	-0.5151	0.0546	0.0000
Number of pedestrians	-0.4139	0.0646	0.0000
Areas for pedestrians to walk or dwell	-0.4886	0.0390	0.0000
Designated pedestrian crossings	-0.5911	0.0459	0.0000
Services and amenities (grocery store, etc)	-0.5233	0.0456	0.0000
Signage (traffic lights, speed limit signs, etc)	-0.5448	0.0528	0.0000
Street Furniture	-0.5354	0.0396	0.0000

Demographic effects were strong, with respondents aged 35–54 (*0.875, $p < 0.001$*) and 55–74 (**0**.*813, $p < 0.001$*) more likely to report that streets felt safe when interacting with cyclists. Income was also significant, with both medium (*1.184, $p < 0.001$*) and high (*1.215, $p < 0.001$*) income groups reporting greater safety than lower-income respondents. Gender and employment status were not statistically significant. Activity-based variables consistently indicated that **inclusive and calm environments improve pedestrian safety around cyclists**. Perceptions of safety increased where streets were rated easier for cycling (*0.305, $p < 0.001$*) and relaxing (*0.272, $p = 0.001$*), as well as when they accommodated all age groups (*0.381, $p < 0.001$*) and people with disabilities (*0.134, $p = 0.05$*). Attributes such as children's play (*0.211, $p < 0.001$*), reading (*0.132, $p = 0.049$*), and working (*0.148, $p = 0.014$*) also made smaller but positive contributions.

By contrast, nearly all improvement priority variables carried negative coefficients, reinforcing that where respondents identified deficiencies, safety was rated lower. The strongest concerns were lack of

pedestrian crossings (*–0.592, p < 0.001*), inadequate signage (*–0.5496, p < 0.001*), insufficient street furniture (*–0.535, p < 0.001*), poor environmental comfort (*–0.564, p < 0.001*), and high motorcyclist (*–0. 515, p < 0.001)*, car (*–0. 593, p < 0.001)*, and heavy vehicles (*–0. 533, p < 0.001)* traffic. Together, these findings highlight that cyclist-related safety perceptions are shaped not only by demographics and inclusive design but also by basic infrastructure. Locations where there is a perceived limitation in crossings, signage, and traffic management tend to undermine perceptions of safety.

4.3.2.3 Motorcyclist Interaction Model

The motorcyclist interaction model is reported in Table 99 and it demonstrates many similarities with the cyclist model while also highlighting some distinct differences.

Table 99: Motorcyclist interaction OLR model estimation results

	Coefficient Value	Standard Error	p-value
Demographic Variables			
Midlife adults (35 to 54 years)	0.9081	0.1389	0.0000
Older adults (55 to 74 years)	1.0460	0.1613	0.0000
Women	-0.0876	0.1214	0.4705
Medium income ($45,001 to $135,000)	1.4681	0.1513	0.0000
High income ($135,001 or more)	0.9492	0.1467	0.0000
Not employed or not self-employed	-0.2984	0.1655	0.0715
Activity Variables			
Cycle	0.2013	0.0617	0.0011
Move, Dwell (Disability)	0.2448	0.0595	0.0000
Drive Car	0.4843	0.0682	0.0000
Kid Play	0.2361	0.0592	0.0001
Read	0.1869	0.0619	0.0025
Work	0.2087	0.0594	0.0004
Improvement Variables			
Areas for cyclists to ride	-0.4343	0.0358	0.0000
Parking areas for cyclists	-0.4025	0.0423	0.0000
Number and/or speed of cyclists	-0.3810	0.0445	0.0000
Public Transport	-0.4395	0.0320	0.0000
Surrounding Buildings	-0.4143	0.0625	0.0000
Areas for motor vehicles to ride	-0.4819	0.0590	0.0000
Parking areas for motor vehicles	-0.3931	0.0421	0.0000
Cleanliness	-0.4591	0.0582	0.0000
Environmental comfort	-0.4641	0.0517	0.0000
Landscaping	-0.4726	0.0417	0.0000
Maintenance	-0.4112	0.0725	0.0000
Number and/or speed of motor vehicles	-0.4571	0.0512	0.0000
Number and/or speed of heavy vehicles	-0.5037	0.0534	0.0000
Number and/or speed of motorbikes	-0.4632	0.0504	0.0000
Number of pedestrians	-0.4323	0.0595	0.0000
Areas for pedestrians to walk or dwell	-0.4258	0.0375	0.0000
Designated pedestrian crossings	-0.4963	0.0455	0.0000
Services and amenities (grocery store, etc)	-0.4500	0.0461	0.0000
Signage (traffic lights, speed limit signs, etc)	-0.4291	0.0505	0.0000
Street Furniture	-0.4501	0.0371	0.0000

Demographic patterns were consistent with the prior models: respondents aged 35–54 (*0.909, p < 0.001*) and 55–74 (*1.046, p < 0.001*) reported higher safety, as did medium- and high-income groups (*1.468 and 0.950, both p < 0.001*). Activity variables also showed close parallels with the cyclist model. Disability access (*0.245, p < 0.001*) and children's play (*0.237, p < 0.001*) were positive and significant in both cases. Ease of driving (*0.484, p < 0.001*) emerged as particularly influential here, a result not as pronounced in the cyclist model, suggesting that orderly traffic conditions are especially important in

shaping perceptions of safety around motorcyclists. Reading (*0.187, p = 0.010*) and working (*0.209, p < 0.001*) also contributed positively.

Improvement priorities again followed the same overall trend, with consistently negative coefficients. Key concerns included poor pedestrian crossings (*–0.504, p < 0.001*), signage (*–0.433, p < 0.001*), and inadequate street furniture (*–0.426, p < 0.001*). Higher traffic volumes and pedestrian congestion further reduced perceived safety. In comparison with the cyclist model, the motorcyclist model reaffirmed the importance of inclusive, activity-friendly environments and adequate infrastructure. The key differences lay in the stronger emphasis on driving-related conditions and in the role of occupation, which highlighted vulnerability among specific groups.

4.3.2.4 Vehicle (car) Interaction Model

Results for the car interaction model are shown in Table 100.

Table 100: Car interaction OLR model estimation results

	Coefficient Value	Standard Error	p-value
Demographic Variables			
Midlife adults (35 to 54 years)	0.8554	0.1368	0.0000
Older adults (55 to 74 years)	0.9467	0.1595	0.0000
Women	-0.0074	0.1229	0.9523
Medium income ($45,001 to $135,000)	1.1735	0.1530	0.0000
High income ($135,001 or more)	0.9643	0.1538	0.0000
Not employed or self employed	-0.0319	0.1678	0.8490
Activity Variables			
Move, Dwell (Disability)	0.1483	0.0565	0.0086
Move, Dwell (All Ages)	0.1682	0.0719	0.0193
Drive Car	0.6188	0.0689	0.0000
Kid Play	0.1358	0.0550	0.0135
Use the Phone	0.2462	0.0636	0.0001
Ride Public Transport	0.1669	0.0553	0.0026
Work	0.1424	0.0555	0.0103
Improvement Variables			
Areas for cyclists to ride	-0.4065	0.0496	0.0000
Parking areas for cyclists	-0.4875	0.0413	0.0000
Number and/or speed of cyclists	-0.4486	0.0493	0.0000
Public Transport	-0.4744	0.0505	0.0000
Surrounding Buildings	-0.5419	0.0500	0.0000
Areas for motor vehicles to ride	-0.4254	0.0376	0.0000
Parking areas for motor vehicles	-0.4839	0.0443	0.0000
Cleanliness	-0.5059	0.0725	0.0000
Environmental comfort	-0.4015	0.0360	0.0000
Landscaping	-0.4561	0.0448	0.0000
Maintenance	-0.4096	0.0465	0.0000
Number and/or speed of motor vehicles	-0.4317	0.0326	0.0000
Number and/or speed of heavy vehicles	-0.4202	0.0679	0.0000
Number and/or speed of motorbikes	-0.4628	0.0523	0.0000
Number of pedestrians	-0.3651	0.0386	0.0000
Areas for pedestrian to walk or dwell	-0.4668	0.0571	0.0000
Designated pedestrian crossings	-0.4604	0.0373	0.0000
Services and amenities (grocery store, etc)	-0.4388	0.0436	0.0000
Signage (traffic lights, speed limit signs, etc)	-0.4739	0.0497	0.0000
Street Furniture	-0.4020	0.0664	0.0000

Age (*0.855 and 0.947, both p < 0.001*) and income (*1.173 and 0.964, both p < 0.001*) remained strong predictors of higher safety perceptions, consistent with the earlier models. Gender and employment status were again non-significant, aligning more with the cyclist model than the motorcyclist model.

Activity-based influences overlapped with both earlier models but with subtle differences. Ease of driving (*0.619, p < 0.001*) emerged as the strongest factor, like the motorcyclist model but more pronounced here. Accessibility for people with disabilities (*0.148, p = 0.001*) and children's play opportunities (*0.136, p = 0.013*) were also significant, echoing patterns from the cyclist and motorcyclist models. Additional activities such as working (*0.142, p = 0.01*), public transport use (*0.167, p = 0.002*), and phone use (*0.246, p = 0.001*) contributed positively, suggesting that multifunctional streets influence safety perceptions more strongly in car-related contexts.

Differences were seen in the improvement priority variables. Negative coefficients were again widespread, but environmental quality stood out: landscaping (*–0.488, p < 0.001*), cleanliness (*–0.467, p < 0.001*), and environmental comfort (*–0.407, p < 0.001*) were more influential here than in the cyclist or motorcyclist models. Signage (*–0.474, p < 0.001*) and pedestrian areas (*–0.425, p < 0.001*) also remained significant, consistent with the broader pattern across models. **The car model therefore shared the demographic and activity-based foundations seen in the cyclist and motorcyclist models, but it placed greater weight on the environmental and aesthetic qualities of the street**. Pedestrians evaluated safety in car-dominated environments not only through functionality but also through the overall upkeep and attractiveness of the setting.

4.3.2.5 Heavy Vehicle Interaction Model

The heavy vehicle interaction model, presented in Table 101, reinforced many of the trends seen across the other three models while introducing additional sensitivities. Age (*0.633 and 0.723, both p < 0.001*) and income (*1.395 and 1.218, both p < 0.001*) remained positive predictors, consistent with the cyclist, motorcyclist, and car models. Unlike those models, however, **gender was significant (*–0.401, p = 0.002*), with women reporting lower safety**.

Activity-based results highlighted both similarities and contrasts. Disability access (*0.176, p < 0.001*) and children's play (*0.306, p < 0.001*) were significant, as in all earlier models. Relaxing (*0.171, p < 0.005*) and public transport use (*0.182, p < 0.002*) also contributed positively, echoing findings from the cyclist and motorcyclist models. However, an activity variable was unique in showing negative effects: walking (*–0.238, p < 0.002*), suggesting that casual pedestrian activities heightened perceptions of risk specifically in heavy vehicle environments.

Improvement priority variables were again overwhelmingly negative, consistent with the other models. Poor cleanliness (*–0.411, p < 0.001*), weak maintenance (*–0.384, p < 0.001*), inadequate signage (*–0.329, p < 0.001*), and insufficient pedestrian areas (*–0.453, p < 0.001*) were among the strongest contributors to lower safety. While these issues were common across all models, their magnitudes were particularly high here, underscoring the acute concerns associated with heavy vehicles.

Taken together, the heavy vehicle model confirmed the demographic and activity-based foundations seen across all earlier models but added two critical insights: the presence of gender and occupation effects, and the negative influence of casual pedestrian activities. Compared with the cyclist, motorcyclist, and car models, safety perceptions in heavy vehicle contexts appear more vulnerable and diffuse, pointing to the heightened risks pedestrians associate with sharing space with large, high-mass vehicles.

Table 101: Heavy Vehicle interaction OLR model estimation results

	Coefficient Value	Standard Error	p-value
Demographic Variables			
Midlife adults (35 to 54 years)	0.6330	0.1486	0.0000
Older adults (55 to 74 years)	0.7227	0.1665	0.0000
Women	-0.4067	0.1234	0.0010
Medium income ($45,001 to $135,000)	1.3950	0.1631	0.0000
High income ($135,001 or more)	1.2183	0.1605	0.0000
Not employed or not self-employed	-0.2628	0.1767	0.1370
Activity Variables			
Move, Dwell (Disability)	0.1756	0.0676	0.0094
Drive Car	0.2565	0.0747	0.0006
Kid Play	0.3055	0.0589	0.0000
Move, Dwell (All Ages)	0.1551	0.0781	0.0471
Relax	0.1706	0.0612	0.0053
Ride Public Transport	0.1824	0.0598	0.0023
Walk	-0.2382	0.0747	0.0014
Work	0.1756	0.0643	0.0063
Improvement Variables			
Areas for cyclists to ride	-0.3418	0.0380	0.0000
Parking areas for cyclists	-0.3196	0.0430	0.0000
Number and/or speed of cyclists	-0.2273	0.0404	0.0000
Public Transport	-0.4225	0.0340	0.0000
Surrounding Buildings	-0.3776	0.0639	0.0000
Areas for motor vehicles to ride	-0.4110	0.0582	0.0000
Parking areas for motor vehicles	-0.3072	0.0565	0.0000
Cleanliness	-0.3460	0.0403	0.0000
Environmental comfort	-0.3843	0.0722	0.0000
Landscaping	-0.3380	0.0568	0.0000
Maintenance	-0.3191	0.0497	0.0000
Number and/or speed of motor vehicles	-0.4844	0.0523	0.0000
Number and/or speed of heavy vehicles	-0.4431	0.0579	0.0000
Number and/or speed of motorbikes	-0.4773	0.0491	0.0000
Number of pedestrians	-0.5592	0.0770	0.0000
Areas for pedestrians to walk or dwell	-0.4529	0.0416	0.0000
Designated pedestrian crossings	-0.4158	0.0450	0.0000
Services and amenities (grocery store, etc)	-0.3637	0.0483	0.0000
Signage (traffic lights, speed limit signs, etc)	-0.3293	0.0522	0.0000
Street Furniture	-0.4976	0.0387	0.0000

4.3.2.6 Model Performance

Like the overall community safety perception models, all four mode-specific models were evaluated using in-sample (80%) and out-of-sample (20%) datasets, with results summarised in Table 102. Evaluation criteria included log-likelihood, prediction accuracy, and the Akaike (AIC) and Bayesian (BIC) Information Criteria.

The cyclist interaction model achieved the highest predictive performance, with an out-of-sample accuracy of **0.59** and relatively lower AIC/BIC values. This aligns with the substantive findings, where safety around cyclists was strongly associated with inclusive activity variables and clear infrastructure features (e.g. crossings, signage), making perceptions easier to model.

The motorcyclist and heavy vehicle models both showed moderate accuracy **(0.53 and 0.56, respectively**) as well as intermediate complexity. This corresponds with their results, which revealed additional sensitivities around occupation, disability access, and gender, making perceptions more varied but still explainable.

By contrast, the car interaction model produced the lowest out-of-sample accuracy (**0.51**) and the highest AIC/BIC values, indicating weaker predictive power. This reflects the model findings, where safety perceptions in car-dominated environments depended heavily on overall environmental and aesthetic features (landscaping, cleanliness, maintenance) rather than a small set of clearly defined variables. Such generic drivers of perception are more difficult to capture statistically, which helps explain the lower model fit.

Taken together, the performance metrics suggest that safety perceptions are most predictable in cyclist contexts, moderately predictable in motorcyclist and heavy vehicle contexts, and least predictable in car contexts. This mirrors the substantive findings: where safety is shaped by specific, tangible street features, the models perform strongly; where perceptions depend on broader environmental quality, the models are less precise.

Table 102: Goodness of fit metrics across all mode-specific interaction models.

Models		Cyclist Interaction	Motorcyclist Interaction	Vehicle (Car) Interaction	Heavy Vehicle Interaction
In sample	Loglikelihood	-1314.75	-1374.21	-1385.35	-1356.22
	Accuracy	0.54	0.49	0.52	0.53
	AIC	2705.50	2820.42	2844.69	2788.45
	BIC	2900.54	3005.19	3034.60	2983.48
Out sample	Loglikelihood	-311.52	-345.77	-355.23	-339.17
	Accuracy	0.59	0.53	0.51	0.56
	AIC	699.03	763.54	784.47	754.34
	BIC	894.07	948.31	974.37	949.37

4.3.2.7 Key Insights across the Mode-Specific Models

Aggregating the results from the cyclist, motorcyclist, car and heavy vehicle interaction models, several key themes emerge:

- **Demographic influences**: Older respondents (35–54 and 55–74) and higher-income groups consistently reported higher safety perceptions across all models. Gender effects were only observed in the heavy vehicle model, where women perceived lower safety. Occupation was significant in the motorcyclist and heavy vehicle models, with unemployed and student groups more likely to perceive lower safety.
- **Activity-based effects**: Disability access and child play were strong positive predictors across multiple models, reflecting the importance of inclusive, family-friendly environments. Relaxing and working also contributed positively in most contexts. Ease of driving emerged as particularly influential in the motorcyclist and car models, linking safety perceptions to orderly vehicle flows. Unique to the heavy vehicle model, casual pedestrian activities such as walking and snacking were negatively associated with safety, suggesting heightened vulnerability in these contexts.
- **Street design and environmental quality**: Improvement priority variables were consistently negative across all models, showing that where respondents identified deficiencies, safety was rated lower. For cyclists, the most pressing issues were crossings and signage; for motorcyclists, crossings and pedestrian management; for cars, landscaping, cleanliness, and environmental comfort; and for heavy vehicles, a broad range of infrastructure concerns including maintenance, signage, and pedestrian areas.
- **Patterns of predictability**: The cyclist model demonstrated the strongest predictive power, with perceptions tied to specific design features that can be readily addressed. Motorcyclist and heavy vehicle models showed moderate predictability, reflecting more varied but still identifiable sensitivities. The vehicle (car) model had the weakest performance, suggesting that safety perceptions in car contexts are shaped by environmental qualities that are more difficult to capture statistically.

These results are broadly consistent with the face-to-face survey findings, which also highlighted the importance of age, income, activity support, and street maintenance in shaping overall perceptions of safety. Both datasets show that inclusive, walkable, and well-maintained environments consistently foster higher safety perceptions, while deficiencies in infrastructure and car-oriented conditions reduce them. The online survey adds an additional layer of nuance by showing how specific road user interactions alter safety concerns, for example, crossings and signage for cyclists, driving and disability access for motorcyclists, environmental quality for cars, and gendered vulnerabilities in heavy vehicle contexts. Together, the two approaches provide complementary insights: the intercept survey identifies the broad factors influencing general perceptions of safety, while the online survey highlights mode-specific issues that practitioners can target in street design and management.

However, while the models identify which variables are statistically significant, they do not by themselves indicate the **relative scale of influence** each variable exerts on pedestrian safety perceptions. This is where elasticity analysis becomes important. By quantifying how sensitive the probability of a given safety outcome is to changes in each explanatory variable, elasticities allow us to compare the practical impact of different interventions. For practitioners, this moves the discussion beyond whether a factor matters, to how much it matters in shaping perceived safety, providing a critical link between statistical modelling and actionable design decisions.

4.3.3 Elasticity Analysis

Elasticity analysis provides an intuitive way to interpret ordered logit regression (OLR) models by quantifying how sensitive predicted probabilities are to changes in explanatory variables. In the context of pedestrian safety perceptions, elasticities describe how a **1% change in an independent variable** (e.g. vehicle speed, pedestrian crossings, environmental comfort) alters the probability of respondents choosing a given safety category (e.g. “Unsafe”, “Safe”, “Very Safe”).

Technically, elasticities are derived from the partial derivative of the OLR probability function with respect to each independent variable, scaled by the mean values of both the variable and the predicted probability. In practice, this means that elasticities capture *percentage changes in probabilities* rather than raw coefficient values, making them more comparable across variables that are measured on very different scales (e.g. binary indicators versus continuous traffic counts). For example, as highlighted in Table 103, in the community safety perception model, a **1% increase in average vehicle speed** increased the probability of respondents rating the site as “Unsafe” by **0.52%**, while reducing the probability of “Very Safe” by **0.78%**. These shifts illustrate how probability mass moves across categories: higher speeds push people away from safer ratings toward unsafe ones.

Table 103: Example of elasticity considering Average Speed (Community Safety Perception Model)

Category	Elasticity of Average Speed
Unsafe (1)	+0.520
Neither unsafe nor safe (2)	+0.368
Safe (3)	-0.042
Very safe (4)	-0.776

By calculating elasticities for all variables, we can compare the **relative impact** of demographic factors, activity-based experiences, and street design features on perceived safety. This provides practitioners with clear guidance on where small improvements are likely to yield the greatest perceptual gains. The next sub-sections provide details of the elasticity analysis for each model estimated. The tables presented in these sections summarise the elasticity results focusing on the most elastic and inelastic variables (*values where elasticity was above the absolute value of 0.3 for any of the safety categories*), a complete set of results are included in Appendix G.

4.3.3.1 Community Safety Perception Model (Normalised)

Elasticity results for the community safety perception model are presented in Table 104.

Table 104: Elasticity results of key variables across the Community Safety Perception model.

Variable	Unsafe (1)	Neither Unsafe nor Safe (2)	Safe (3)	Very Safe (4)
Average Speed	0.520	0.368	-0.042	-0.776
Traffic Volume	0.028	0.018	-0.004	-0.035
Pedestrian Count	-0.009	-0.007	0.001	0.014
Pedestrian Safety, Regarding Crime	-0.695	-0.591	0.003	1.302
Pedestrian Safety, Regarding motor vehicles	-0.753	-0.615	0.013	1.355
Appropriate Speed Choice	-0.694	-0.496	0.056	1.041
Number and/or speed of motor vehicles	-0.190	-0.159	0.003	0.347
Areas for pedestrians to walk or dwell	-0.403	-0.308	0.014	0.683
Designated pedestrian crossings	-0.263	-0.190	0.017	0.410
Environmental comfort	-0.255	-0.219	0.000	0.482
Cleanliness	-0.191	-0.159	0.002	0.349
Maintenance	-0.379	-0.319	0.010	0.679

As described earlier, vehicle speed emerged as one of the most elastic variables confirming the earlier coefficient results, where speed was negatively associated with safety perceptions. The strongest elasticities were observed for **perceived pedestrian safety with respect to crime and motor vehicles**, reaching values of up to *+1.35* for "Very Safe" and around *–0.70 to –0.75* for "Unsafe". These results validate the regression findings that perceptions of crime and traffic risk are central drivers of overall community safety. Moderate elasticities for **street suitability features** such as walk/dwell areas *(+0.68* "Very Safe"), environmental comfort (*+0.48*), and maintenance (*+0.68*) reinforce the earlier conclusion that improvements in these domains meaningfully shift perceptions, even if their coefficients were smaller in magnitude than those for safety and speed. Crossings showed smaller elasticities, while cleanliness and signage had limited influence, consistent with their weaker coefficient results. Together, the elasticity results provide a practical confirmation of the model estimates: they show that **speed, crime and traffic-related safety, and key pedestrian infrastructure** exert the largest influence on how safe pedestrians feel in shared spaces.

4.3.3.2 Cyclist Interaction Model

Elasticity results for pedestrian safety perceptions when interacting with cyclists are presented in Table 105.

Table 105: Elasticity results of key variables across the Cyclist Interaction model.

Improvement Variables	Unsafe (1)	Neither Unsafe nor Safe (2)	Safe (3)	Very Safe (4)
Public Transport	0.367	0.129	-0.025	-0.600
Cycling Area	0.252	0.085	-0.011	-0.417
Cyclist Parking	0.121	0.096	-0.064	-0.341
Street Furniture	0.165	0.074	-0.008	-0.289
Areas for pedestrians to walk or dwell	0.251	-0.029	-0.123	-0.166
Parking areas for motor vehicles	0.214	-0.011	-0.112	-0.145
Designated pedestrian crossings	0.228	-0.014	-0.122	-0.149

Several variables showed strong elasticities, confirming that relatively small changes in street design or conditions can meaningfully shift safety perceptions. The strongest elasticities were linked to infrastructure deficiencies affecting cyclists, pedestrians, and public transport users. In particular, inadequate public transport had the largest impact, increasing the probability of an "Unsafe" rating by

0.37% for each 1% change and decreasing the probability of a "Very Safe" rating by 0.6% for each 1% change. This was followed by deficiencies in cycling areas (*+0.25*), pedestrian areas (*+0.25*), and pedestrian crossings (*+0.23*). Poorly designed cyclist parking (*–0.34*) and poor cycling facilities (*–0.41*) reduced the likelihood of higher safety ratings. These findings suggest that **improvements to crossings, active transport infrastructure, and public transport accessibility are among the most effective levers** for enhancing perceived safety in the cyclist interaction model.

4.3.3.3 Motorcyclist Interaction Model

Elasticity results for pedestrian safety perceptions around motorcyclists are presented in Table 106.

Table 106: Elasticity results of key variables across the Motorcyclist Interaction model.

Improvement Variables	Unsafe (1)	Neither Unsafe nor Safe (2)	Safe (3)	Very Safe (4)
Public Transport	0.353	0.152	-0.027	-0.569
Areas for cyclists to ride	0.293	0.106	-0.029	-0.440
Parking areas for cyclists	0.164	0.081	-0.011	-0.278
Street Furniture	0.366	0.091	-0.116	-0.372
Landscaping	0.204	0.061	-0.051	-0.240
Services and amenities (grocery store, etc)	0.193	0.057	-0.067	-0.196
Areas for pedestrians to walk or dwell	0.268	0.007	-0.113	-0.162
Parking areas for motor vehicles	0.175	0.031	-0.074	-0.133
Designated pedestrian crossings	0.222	0.030	-0.099	-0.150

Similar to the cyclist model, the motorcyclist model showed that the largest elasticities were linked to deficiencies in core infrastructure. Poor public transport design and inadequate street furniture increased the likelihood of an "Unsafe" rating by approximately 0.35% for each 1% change, followed by deficiencies in cycling areas (*+0.29*), pedestrian areas (*+0.26*), and pedestrian crossings (*+0.22*). Conversely, poor public transport (*–0.57*), poor cycling areas (*–0.44*), and inadequate street furniture (*–0.37*) significantly reduced the probability of a "Very Safe" rating. These results indicate that motorcyclist safety perceptions are **sensitive to the design quality of active transport and supporting infrastructure**, highlighting the importance of improvements in public transport, cycling, pedestrian areas, and overall streetscape design.

4.3.3.4 Vehicle (car) Interaction Model

Elasticities for the car interaction model are shown in Table 107.

Table 107: Elasticity results of key variables across the Car Interaction model.

Improvement Variables	Unsafe (1)	Neither Unsafe nor Safe (2)	Safe (3)	Very Safe (4)
Public Transport	0.3805	0.2221	-0.003	-0.586
Areas for cyclists to ride	0.2855	0.1575	-0.005	-0.444
Parking areas for cyclists	0.2133	0.1163	-0.002	-0.32
Street Furniture	0.415	0.1699	-0.081	-0.419
Landscaping	0.2501	0.1057	-0.055	-0.244
Services and amenities (grocery store, etc)	0.2037	0.1008	-0.047	-0.209
Areas for pedestrians to walk or dwell	0.3081	0.0601	-0.092	-0.185
Parking areas for motor vehicles	0.1733	0.0582	-0.042	-0.147
Designated pedestrian crossings	0.2459	0.0701	-0.073	-0.17

The largest negative elasticities were linked to public transport quality, with a 1% decline reducing the probability of a "Very Safe" rating by 0.58%. This was followed by cycling areas (*-0.44*) and street furniture quality (*-0.42*). When compared with the cyclist and motorcyclist interaction models, the car interaction model revealed similar sensitivity patterns. Poorly designed street furniture (*0.41*),

inadequate public transport (*0.38*), and deficiencies in cycling (*0.29*) and pedestrian (*0.31*) areas all increased the probability of an "Unsafe" rating for each 1% change. Collectively, these results indicate that **perceived safety across all modes is closely tied to the design quality of active transport and supporting infrastructure**, underscoring the need for well-integrated cycling, pedestrian, and public transport facilities to enhance overall safety.

4.3.3.5 Heavy Vehicle Interaction Model

Elasticity results for heavy vehicle interactions are presented in Table 108.

Table 108: Elasticity results of key variables across the Heavy Vehicle Interaction model.

Improvement Variables	Unsafe (1)	Neither Unsafe nor Safe (2)	Safe (3)	Very Safe (4)
Public Transport	0.3002	0.0598	-0.064	-0.506
Areas for cyclists to ride	0.1929	0.0454	-0.035	-0.337
Parking areas for cyclists	0.1143	0.046	-0.018	-0.217
Street Furniture	0.3347	-0.043	-0.18	-0.357
Areas for pedestrians to walk or dwell	0.2105	-0.085	-0.141	-0.149

The heavy vehicle interaction model revealed that deficiencies in active transport infrastructure, public transport, and environmental design had the most pronounced effects on perceived safety. Poor public transport quality (*-0.51*), inadequate cycling areas (*-0.34*), and low street furniture quality (*-0.36*) were all associated with a reduced probability of a "Very Safe" rating for each 1% change in these factors. Conversely, the same variables were significant contributors to "Unsafe" perceptions, with poor public transport (*0.30*), inadequate street furniture (*0.33*), and deficient pedestrian areas (*0.21*) increasing the likelihood of an Unsafe rating. These findings suggest that, consistent with the previous models, **perceived safety in heavy vehicle contexts is particularly sensitive to the quality of supporting infrastructure** and the broader street environment.

4.3.3.6 Summary of Elasticity Analysis

Across the four interaction models (cyclist, motorcyclist, car, and heavy vehicle), the elasticity analysis revealed consistent sensitivity to infrastructure quality, along with mode-specific differences. Public transport, cycling areas, pedestrian zones, and street furniture were the most influential factors shaping perceived safety. Poor public transport showed the highest positive elasticity for "Unsafe" ratings, while improvements in cycling infrastructure and street furniture most strongly increased "Very Safe" ratings.

Overall, the findings suggest that **while enhancing public and active transport infrastructure provides broad safety benefits, interventions should be tailored to the specific sensitivities of each transport mode** to achieve the best outcomes.

4.3.4 Summary of Modelling Outcomes

The statistical modelling performed has revealed how pedestrians perceive safety in shared spaces, combining insights from both the intercept (face-to-face) survey and the online survey. Taken together, these results highlight the broad factors shaping community safety as well as the specific sensitivities that arise when pedestrians interact with different types of road users.

From the **intercept survey**, (Community Safety Perception model) the results indicate that:

- **Demographics matter**: Older and higher-income respondents consistently reported feeling safer.
- **Activity support is central**: Walking was the strongest predictor of safety, with relaxing and exercising also positive. Conversely, car-oriented environments reduced safety perceptions.

- **Street design and upkeep are influential**: Well-maintained, comfortable, and pedestrian-friendly environments improved perceptions, while poor crossings or inadequate pedestrian space detracted from them.
- **Security is fundamental**: Perceptions of safety in relation to crime and traffic risk were among the most powerful predictors of overall community safety.
- **Traffic measures** such as volumes and speeds showed expected directional effects but limited statistical significance in this dataset.

The **online survey models** built on these findings by examining mode-specific interactions:

- **Cyclists**: Safety perceptions were strongly linked to crossings, signage, and traffic management, alongside inclusive features such as child play and disability access.
- **Motorcyclists**: Orderly traffic conditions (ease of driving) were especially important, with occupation-related differences highlighting vulnerabilities among students and unemployed respondents.
- **Cars**: Environmental quality (landscaping, cleanliness, comfort) played a larger role than in other models, showing that safety in car-dominated contexts depends heavily on overall upkeep and organisation.
- **Heavy vehicles**: Pedestrian safety was shaped by a wide range of deficiencies (cleanliness, signage, pedestrian areas) and revealed unique vulnerabilities, including lower safety perceptions among women and negative effects for casual activities such as walking and snacking.

The **elasticity analysis** reinforced and clarified these results by showing which variables have the greatest *practical impact* on safety perceptions:

- **Consistent across models**: Crossings, public transport, cycling and pedestrian area and street furniture had some of the largest elasticities when rated as deficient, making them universal priorities.
- **Context-specific drivers**: Speed and perceptions of crime/traffic risk dominated in the intercept survey, while street furniture, pedestrian areas, and public transport integration were especially elastic in the online survey models.
- **Inclusive design features** (disability access, child play) consistently increased the probability of higher safety ratings.

For practitioners, these findings provide clear direction:

- **Focus on fundamentals** such as safe crossings, clear signage, and decluttered furniture layouts, as these deliver the greatest gains across all contexts.
- **Tailor interventions by mode**: provide dedicated and legible spaces around cyclists and motorcyclists; emphasise cleanliness, landscaping, and comfort in car-oriented streets; and strengthen maintenance, separation, and infrastructure in heavy vehicle environments.
- **Manage speed and security perceptions** proactively, as these remain decisive in shaping community confidence.

By linking model estimation with elasticity analysis, the study moves beyond identifying what matters, to showing **how much it matters**. This provides practitioners with a hierarchy of interventions that can deliver the most meaningful improvements in pedestrian safety perceptions and support the delivery of safer, more inclusive street environments.

5 Practitioner Guidance for enhanced Shared Space Development

The multi-faceted approach to the empirical investigation has yielded several tools and insights and the following section aims to transform these findings into guidance for practitioners in the context of shared space development. This section consolidates the technical analyses, modelling outputs, and community engagement findings presented earlier in the report and interprets them through the lens of policy and design application. It is structured around three key areas: (i) implications for the **NSW Speed Zoning Standard**, (ii) implications for the **Design of Roads and Streets (DORAS) manual**, and (iii) **Pathways for translating the research into practice** through the application of new analytical tools. Together, these subsections provide a bridge between the research outcomes presented here and the operational frameworks used by designers, planners, and decision-makers to deliver safer, more inclusive, and context-sensitive street environments.

5.1 Implications for the NSW Speed Zoning Standard (TS 03631:2.0)

New South Wales Speed Zoning Standard (TS 03631, effective July 2023, revised September 2025) provides a comprehensive framework for setting speed limits, including for low-speed environments. Several principles in the Standard directly relate to the findings of the research, and there are opportunities to integrate these outcomes to enhance practitioner guidance.

5.1.1 Reinforcing Safe Systems Principles

The Standard's Principle 1 is to set speed zones to *minimise harm*, aligning with the Safe System approach (NSW Speed Zoning Standard, Section 8.1). It emphasises that VRUs face a high risk of serious injury at impact speeds above 30 km/h, and thus their needs should take priority. The project's crash analysis confirmed that VRUs remain disproportionately represented in casualty outcomes within speed environments 30km/h or less, even where absolute crash numbers were low. Speed compliance analysis adds important nuance. The data show that driver compliance is weakest at very low posted limits (equal to or less than 30 km/h), with a substantial proportion of vehicles exceeding the limit even though actual average speeds remain relatively low. By contrast, compliance improves in 40–50 km/h zones, where fewer than 3% of vehicles were recorded above the limit. Though there are few locations, this suggests that lower limits (10km/h to 30km/h) require strong design measures (e.g. raised crossings, road/street narrowing, surface treatments) and targeted enforcement to ensure drivers travel at the intended safe speeds. Survey evidence further supports this principle: when asked about "appropriate speeds" for shared environments, most respondents indicated that existing limits should be maintained or reduced, with strong support for limits at or below 40 km/h. This demonstrates clear community acceptance of slower environments in pedestrian-oriented places. Taken together, **the analyses reinforce the need for practitioners to prioritise low-speed settings in shared and high pedestrian activity areas.** The findings strengthen the case for **wider application of 30 km/h and 40 km/h zones, while also underscoring the importance of pairing these limits with supportive design and enforcement strategies** to deliver Safe System outcomes in practice.

In terms of evaluating road safety risk, Section 10.5.1.3 of the Standard presents a comprehensive guide to evaluating safety in the context of vehicle movements but currently lacks detail on how to account for crash risk in relation to vulnerable road users (VRUs). **Section 3.5 of this research report demonstrates an approach to estimate crash risk for pedestrians and cyclists by combining crash records with exposure measures**, derived from advanced modelling of walking and cycling volumes. This exposure-based framework allows **risk to be expressed as crashes per pedestrian or cyclist movement, rather than relying solely on raw crash counts of VRUs.** Incorporating this perspective provides a more balanced assessment, ensuring that locations with disproportionately high risks to pedestrians or cyclists are identified, even if absolute crash numbers are low. The inclusion of infrastructure context, such as separated cycleways and low-speed environments, further refines this approach, offering practitioners a practical methodology to prioritise interventions in shared and mixed-use environments. Importantly, **embedding this form of analysis into the Standard would directly**

support the Safe System principle by ensuring speed management and risk assessment are based on a multi-modal dimension accounting for all human vulnerabilities, not just vehicle movements, thereby reducing the likelihood of severe outcomes for those most at risk.

5.1.2 Aligning Speed with Place Context

The Standard's Principle 2 mandates that speed zones *align with the surrounding environment to support liveability, amenity, and successful places*. It explicitly notes that **vulnerable road users (pedestrians and cyclists) face a high risk of serious injury at impact speeds above 30 km/h**, and thus their needs should take priority in speed setting. **The analysis of crash statistics presents clear evidence that areas with greater pedestrian activity will benefit greatly from reduced speed limits**. There is a strong positive correlation (between 0.60 and 0.75) associated with total crashes, injuries and fatalities as speed limits increase (see Table 8), further corroborating the Standard observation. Furthermore, the crash risk is lowered when there is appropriate infrastructure available for walking and cycling.

In practice, it means that in town centres, main streets, or other place-rich contexts, the speed limit should be set low enough to foster a people-friendly atmosphere (allowing the use of civic design elements, outdoor dining, etc.). The subjective data analysis provides further evidence that communities value such alignment. Responses appreciated the **upkeep and maintenance of streets and regularly advocated for increasing pedestrian and cyclist amenity while reducing speed limits**. Based on the results, if a practitioner is designing a busy street, adjacent to public transport with cafes and foot traffic, this should not have the same 50 km/h limit as another local road, because the higher place function warrants a slower, safer setting. The Standard now accommodates this by offering the **30 km/h** "High Pedestrian Activity Area" (HPAA) category, which is a notable advancement. **Section 13.2 of the Standard provides comprehensive guidance for HPAA, but it does not explicitly reference Section 10.3, which outlines the detailed process for assessing Movement and Place functions (inclusion in Version 2.0 of the Standard).** Therefore, there is a risk that practitioners who proceed directly to Section 13.2 may not be prompted to review the foundational Movement and Place assessment contained in Section 10.3, even though it is essential for determining the appropriate speed environment for HPAAs. The intention of the revision is to highlight this procedural gap and reinforce the need for Section 10.3 to be considered in parallel with Section 13.2. The research further supports this by providing regional crash and risk maps that help identify and prioritise locations where revised speed treatments may be appropriate.

5.1.3 Self-Explaining and Compliance-Supporting Design

Principle 4 of the Standard emphasises that speed zones should be *self-explanatory, consistent, and support compliance*. Therefore, the road environment design must align with the posted speed limit and drivers should intuitively understand the appropriate speed from the environment cues (roadway width presence of pedestrians, landscaping, etc.). As stated earlier, the case study findings revealed that most survey respondents desired speed limits at or below the stipulated posted speed limits. The objective data generally aligned with this sentiment, as all but one location had 85th percentile speeds that were 5 to 50% lower than posted speed limits of 30km/h or 40km/h. This indicates that those locations had supportive designs. However, all locations with 10km/h speed limits had 85th percentile speeds that varied between 16km/h and 30km/h indicating that the current approach to designing this infrastructure is not clear to drivers that speeds should be much lower. **The results for the 3 case studies align with Compass IOT speed compliance evaluation across all roads in NSW (Section 3.4) further warranting the need to re-evaluate the definition of 10km/h streets.**

The intercept and online survey data and the associated perceived safety OLR models provide further insight into why compliance issues arise and what users expect of the road environment. Respondents consistently associated perceptions of safety with environments where **design cues matched the posted speed**. For example, narrow carriageways, raised crossings, or the visible presence of pedestrians encouraged support for lower limits. Conversely locations without those clear pedestrian

priority features, respondents often questioned the appropriateness of very low posted limits, such as 10 km/h. Importantly, many participants highlighted the need for **stronger transitional design elements**, such as gateway treatments, paving changes, or signage, to clearly signal the shift into a shared or very low-speed environment, which is consistent with past research (Elliot et al., 2017; Karndacharuk et al., 2013; Wijayaratna et al., 2024; Wijayaratna et al., 2022).

5.1.4 Engaging Communities and Local Government

Principle 6 of the Standard highlights the importance of engaging with local government and the community in the speed setting process. The research methodology presented in this project (use of community surveys) exemplified this engagement and provided invaluable understanding of perceived safety. Section 10.5.2 of the Standard presents the approach to conduct a "*Community engagement assessment*" which states the following:

> "*Practitioners shall undertake an engagement assessment as part of the speed zone review with their nominated Community and Customer Engagement (CCE) team. This assessment should be undertaken at the start of the speed zone review process to allow sufficient time for a communications and engagement plan to be developed. The plan shall document how TfNSW will work with road safety partners, such as local government, and set communication expectations*"

While this guidance establishes a framework for engagement, it remains generic and does not provide specific tools or methods to support practitioners. The Standard could be strengthened by referencing established resources such as the *Austroads Guide to Traffic Management, Part 8: Local Street Management*, which sets out practitioner processes in more detail. The latest version of the Standard makes reference to the "*TfNSW Speed Zoning Engagement Guidelines*" which is currently listed as an internal document as part of the transport standards in NSW. Therefore, there is progress in providing additional guidance for practitioners however publicising such documents would be an important next step.

In addition, there is clear opportunity to integrate the **survey tools developed through this research** as practical mechanisms for community engagement. The intercept survey offers rich, site-specific insights into the functionality, design attributes, and perceived safety of street environments, making it particularly useful when evaluating a proposed speed zone change or a local transformation project. By contrast, the online survey provides a cost-effective means of capturing broader community perspectives, suitable for informing strategic decisions such as introducing area-wide low-speed environments**. Incorporating references to these types of tools within the Standard would enhance its practical value, providing practitioners with proven methods to capture community sentiment.** This would not only improve the quality of engagement but also ensure that speed zoning decisions reflect both technical evidence and the lived experiences of local communities.

5.1.5 Recommendations for Improving the NSW Speed Zoning Standard

Summarising the discussion presented in the previous sub-sections, Table 109 provides recommendations for improving the NSW Speed Zoning Standard based on the findings of the research project. The analysis of the NSW Speed Zoning Standard highlights several opportunities to strengthen its alignment with Safe System principles and to ensure it better reflects the realities of shared and pedestrian-priority environments. The recommended amendments emphasise the importance of embedding exposure-based risk assessments, linking speed management more directly with the Movement and Place framework, clarifying the practical application of very low-speed zones, and providing practitioners with proven methods to engage communities. Together, these refinements would enhance the Standard's clarity, improve compliance outcomes, and give practitioners a more robust evidence base to support speed zoning decisions.

Table 109: Recommendations for improving the NSW Speed Zoning Standard

Reference Section	Recommended Amendment	Impact for Practitioners
Reinforcing Safe System Principles *(Standard: Section 8.1, Section 10.5.1.3)*	• Expand ***Principle 1*** to highlight that compliance at very low speed limits (≤ 30km/h) requires design-led measures and targeted enforcement. • Update **Section 10.5.1.3** to include exposure-based crash risk assessment for pedestrians and cyclists (crashes per VRU volumes), in addition to vehicle-based measures	• Provides clear direction on how to achieve Safe System outcomes in practice. • Ensures risk assessments account for VRUs, allowing practitioners to identify high-risk locations in the context of active transport users. • Supports an evidence-based approach to introduce lower speed environments.
Aligning Speed with Place Context *(Standard: Section 13.2, Section 10.5.1.3)*	• Ensure an explicit reference within **Section 13.2** to **Section 10.3** of the Standard to clarify to practitioners that the design of HPAAs must account for the NSW Movement and Place framework.	• Improves consistency between speed zoning and place-based planning. • Ensures practitioners select speeds that match street activity and context.
Self-Explaining and Compliance-Support Design *(Standard: Section 10.3.3, Section 13.3, Section 10.3)*	• Re-evaluate the current definition and application of 10 km/h shared zones (**Section 10.3.3 and Section 13.3**). Consider whether a 20 km/h default may be more practical in NSW conditions, supported by strong transitional design cues, except in unique environments where 10 km/h can be self-enforced (e.g. laneways, plazas). Further research is necessary to explore this option. • Clarify that design must visibly reinforce the intended speed to both drivers and vulnerable users (***Principle 4***).	• Improves compliance and credibility of shared zones by setting a speed that better reflects real-world behaviour, while still ensuring vulnerable road user safety. • Improves perceived safety and user confidence in shared spaces and lower speed environments.
Engaging Communities and Local Government *(Standard: Section 8.6, Section 10.5.2)*	• Expand **Section 10.5.2** beyond generic requirements by referencing Austroads Guide to Traffic Management Part 8 for detailed practitioner processes. • Include community survey tools (intercept and online surveys) as recommended engagement mechanisms for speed zone reviews.	• Provides practitioners with tested tools to capture community sentiment. • Improves the quality of engagement and alignment between technical evidence and public experience. • Strengthens legitimacy and acceptance of speed zoning decisions.

5.2 Implications for NSW Design of Roads and Streets (DORAS) Manual

The NSW Design of Roads and Streets (DORAS) manual (TS 00066) provides practitioners with a human-centered, context-sensitive approach to road design. It emphasises designing for safety and for people, principles that align closely with the research findings presented in the report. Aligning with the NSW Speed Zoning Standard, the manual explicitly encourages consideration of the Movement and Place framework and Safe Systems Principles, which means that designers must balance transport efficiency with the needs of pedestrians and the creation of vibrant public spaces.

Figure 51 is the reproduced *Figure 5b* within the DORAS manual. It details the planning and design process required to deliver a road or street in NSW. The framework describes workflow across six stages: establishing a vision for the network, defining place and movement context, assessing current performance, identifying issues and opportunities, developing and testing design options, and finalising a preferred option. Community consultation is embedded at both the vision-setting and option-finalisation stages to ensure designs reflect local needs. Each step is supported by specific DORAS sections, including guidance on street typologies, design parameters, and network planning tools. The process is iterative, encouraging refinement of options until they align with objectives. **The findings arising from this research can also be connected to this framework, identifying the implications for DORAS.**

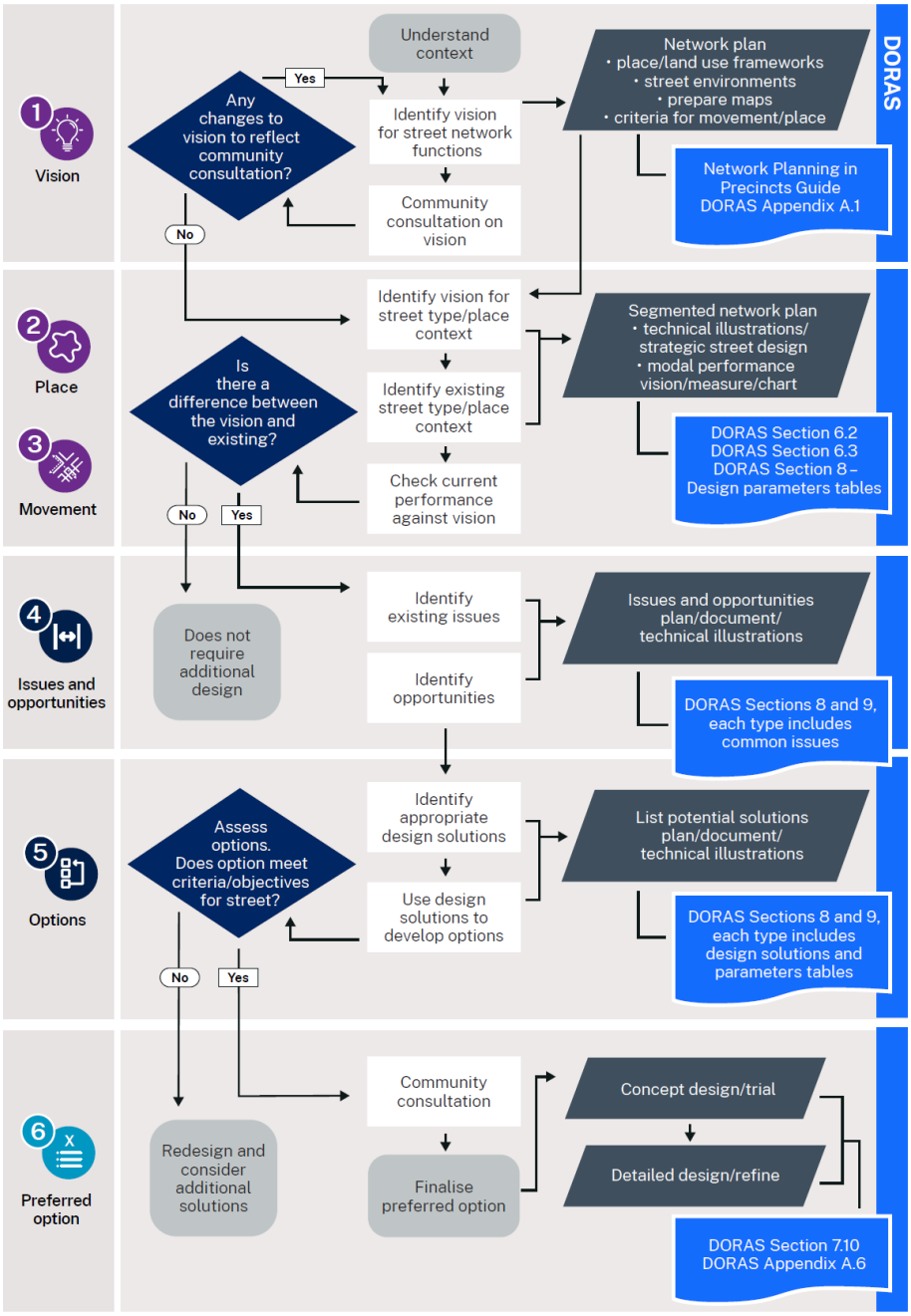


Figure 51: Reproduction of "*Figure 5b - Flow chart on the planning and design process and where to find resources during each step*" from DORAS (2023)

5.2.1 Incorporation of Safety in the Identification of Issues, Opportunities and Options

Sections 5.2 and 5.3 of DORAS outline a process for identifying existing issues and opportunities, supported by conventional data sources such as traffic volumes, crash history, built environment indicators and street performance measures. While effective, this approach does not yet incorporate broader indicators of risk specific to shared or multi-modal environments. The research undertaken through this project provides additional datasets and analytical tools that could strengthen this process.

Crash risk assessments, near-miss data, speed compliance analysis and safety maps provide a more comprehensive evidence base, allowing practitioners to move beyond raw crash counts and to identify areas where vulnerable road users are exposed to disproportionate risk. For example, crash risk indices normalised by walking and cycling volumes highlight locations where the

relative danger per trip is unacceptably high, even if the absolute crash numbers appear moderate. Safety maps combining near-miss observations with crash statistics offer a spatial lens for identifying hotspots that may not yet be reflected in official records.

The research findings reaffirm the duality of shared spaces discussed in recent literature (Batista, 2023; Batista et al., 2023; Batista & Friedrich, 2022; Wijayaratna et al., 2024; Wijayaratna et al., 2022). These environments are designed to increase active transport movements and public place activity while still accommodating motor vehicle access. **Achieving this balance requires a zone-based approach supported by clear gateway treatments and transitional design elements that signal to drivers a shift in behaviour is expected.** Raised crossings, kerb extensions, textured pavements, and landscaping features all act as cues that pedestrian and cyclist movement is prioritised, while refuge islands and marked spaces give vulnerable road users points of comfort within the carriageway. The combination of objective measures, subjective survey results, and compliance analysis presented in this project demonstrates that these elements are essential for reducing conflict, lowering speeds, and improving both perceived and actual safety. Integrating such insights into DORAS would ensure that issue identification and opportunity mapping respond directly to the safety needs of shared space contexts.

5.2.2 Integration of Community Insights into Issue Identification

Community consultation in DORAS is positioned primarily as a means of shaping project vision and selecting preferred options (Section 5.1 and Section 5.4). However, **evidence from this project shows that consultation can also be a powerful source of data during the issue identification stage**. The intercept and online survey tools developed captured rich insights into how communities perceive the safety, functionality and comfort of their local streets. When combined with objective measures such as crash statistics and speed compliance data, this information provides a more holistic understanding of where problems exist and what improvements are valued. Survey data revealed clear patterns in user expectations across different contexts. The face-to-face surveys undertaken across the case study sites **highlighted context-specific issues, revealing variation in how different streets support community needs**. For example, results showed that furniture provision, active transport facilities, and pedestrian–vehicle interactions were consistently influential in shaping user experience. Pneumatic tube data added further context, indicating that heavy vehicles comprised 4-9% and cyclists/motorcyclists 1-4% of flows across most sites, with pedestrian activity consistently higher on weekends. These results emphasise the importance of designing for fluctuating demand patterns and of considering modal mix when identifying issues and opportunities. Online survey results reinforced these findings but provided greater consistency across sites. Street furniture was the feature most frequently identified as needing improvement, followed by areas for cyclists to ride, public transport accessibility, and bicycle parking facilities. Safety concerns were also consistently prioritised, with "*pedestrian interactions with motor vehicles*" ranked first across most streets, followed by cyclist–vehicle and cyclist–pedestrian interactions. Positive associations such as *happy*, *beautiful*, and *quiet* were used to describe many streets, while terms like noisy or ugly at some locations indicated design or maintenance factors undermining comfort and safety.

Together, these insights demonstrate how structured community engagement can complement technical datasets by pinpointing not only where problems exist but also which aspects of the environment most affect perceptions of safety and usability. **Embedding these methods into DORAS would ensure that issue identification is informed by both technical evidence and lived experience**, consistent with *Principle 6* of the *NSW Speed Zoning Standard*, which emphasises meaningful engagement with communities and local government throughout the speed management process.

5.2.3 Use of Case Study References

Section 8.2 of DORAS provides design parameter tables and typical solutions for common issues across street types. While this guidance is technically comprehensive, it is abstract in nature and does not give practitioners real-world examples of how principles have been successfully applied. While the figures and appendices reference specific locations of example sites for different street and road types, the accompanying discussion is minimal and no field data is provided to contextualise the sites. **The case studies compiled in this project offer an opportunity to bridge this gap by providing tangible illustrations and empirical data of shared and low-speed environments in practice**.

Across the 12 case study sites, a range of treatments were observed that delivered both safety and amenity outcomes. For example, Chisholm Street (Darlinghurst), features such narrow traffic lanes, low rise buildings (with no yards) framing the road and further reducing the perceived width, tiled pavements, inclusion of speed cushion, dense landscaping and clear pedestrian priority signage reinforced a 10 km/h environment. This combination of design cues created a self-regulating slow-speed environment, resulting in high levels of pedestrian satisfaction and better speed compliance, especially in comparison with the other shared zone environments. Other case studies showed the role of greenery, street furniture, and textured pavements in naturally calming traffic and enhancing user comfort. These interventions demonstrated that aesthetic elements often double as safety devices, by both slowing vehicles and encouraging pedestrian use.

By incorporating case study references into DORAS, practitioners would have access to benchmark examples that illustrate how theoretical principles translate into practice. This would provide a more practical toolkit, enabling practitioners to compare local conditions with tested environments, select appropriate treatments with greater confidence, and adapt designs to ensure they meet both functional requirements and community expectations.

5.2.4 Recommendations for Improving the NSW Design of Roads and Streets (DORAS)

The evaluation of project findings against the NSW Design of Roads and Streets (DORAS) manual highlights several areas where the guidance could be enhanced to better support practitioners in planning and designing shared and low-speed environments. While DORAS provides a robust framework for vision setting, issue identification, and design solution development, the analysis shows opportunities to integrate additional data sources, embed community insights more explicitly, and expand the use of case study material to illustrate practical applications. These refinements would strengthen the manual's ability to operationalise Safe System and Movement and Place principles, improve alignment with community expectations, and provide practitioners with a more comprehensive evidence base for decision-making. Table 110 summarises the recommended amendments.

Table 110: Recommendations for improving DORAS

Reference Section	Recommended Amendment	Impact for Practitioners
Incorporation of safety in the identification of issues, opportunities and options *(DORAS: Section 5.2, Section 5.3, Section 8.2, Section 8.5 and Section 9)*	• Expand the evidence base listed in **Section 5.2 and 5.3** to include crash risk assessments, near-miss data, speed compliance rates, and safety maps. • For local street, civic spaces and intersections (**Section 8.2, 8.5 and 9**) that have shared environments, highlight the zone-based approach to shared space design. • Inclusion of OLR modelling outcomes as indicators to impacts on perceived safety within the typologies investigated in the research. (This methodology can also be expanded for other typologies within the DORAS manual).	• Provides practitioners with safety specific tools to improve risk identification. • Ensures that safety evaluations capture both objective outcomes and perceived risks, supporting the design of self-enforcing shared environments.
Integration of community insights into issue identification *(DORAS: Section 5.2)*	• Position community consultation as an evidence source for problem identification. • Encourage the use of intercept and online survey tools (developed in this project) in **Section 5.2 and 5.3** to systematically capture perceptions of functionality, design and safety.	• Strengthens the issue identification process by integrating lived experience with technical datasets. • Builds legitimacy for interventions and ensures designs reflect both performance evaluations and community expectations.
Use of Case Study references *(DORAS: Section 8.2, Section 9)*	• Supplement design parameter tables (**Section 8.2.9**) with case study references (from this research and other validated sources)	• Provides practitioners with real-world benchmarks and evaluated precedents. • Increases the confidence in applying DORAS guidance and encourages context-sensitive interpretation of shared space principles.
Additional Mapping for Communication (*DORAS Appendix inclusion*)	• Providing practitioners a dynamic **overlayed map of the DORAS typology across the NSW road network**. Allows practitioners a common reference for the definition of a location (“Destination High Street” versus “Connector Street”)	• Improves consistency in evaluations of future case studies accounting for both NSW Movement and Place framework and the NSW Speed Zoning Standard.

5.3 Translating Research into Practice

The suite of tools and analytical methods developed through this project provides practical pathways for integrating evidence-based safety evaluation into everyday planning and design practice. The following sub-sections outline hypothetical “what-if” applications demonstrating how practitioners within Transport for NSW, Local Councils, or Design Consultancies could use each product to inform decision-making.

5.3.1 Safety Mapping

The GIS safety mapping platform integrates crash records, reported near-miss data, and network-wide speed data across the Greater Sydney area for 2022-2023 (overlap of available data). Individual layers can be filtered by road hierarchy, user type, or speed limit, allowing practitioners to visualise how different safety indicators spatially overlap.

Key applications include:

- **Network screening and prioritisation:** Practitioners can overlay crash density, near-miss frequency, and compliance layers to locate corridors where risk factors coincide. These maps can support road safety campaigns (Towards Zero, “Get your hand off it”, “Share the road”, etc) by identifying priority zones for investigation.
- **Concept planning**: In early project stages, designers can extract heat-map layers to visualise “pressure points” in town centres, identifying intersections with high pedestrian flows and excessive 85th percentile speeds. Such evidence can be used to justify a 30km/h limit, gateway treatments, or raised thresholds.

- **Performance monitoring and evaluation**: Post implementation, the platform can incorporate new data to compare before and after impacts of near-miss frequences, quantifying effectiveness in an accessible visual form for project evaluation reports.
- **Strategic coordination**: TfNSW and Councils can share standardise GIS layers, enabling state-wide identification of systemic risks and compliance trends that feed directly into funding priorities.

Figure 52 presents a potential scenario of application describing a Local Council leveraging the safety mapping tool to form an evidence-based justification for a program of raised pedestrian crossing. The platform developed in this project converts disparate datasets into a coherent spatial system that supports data-driven prioritisation and post-project validation.

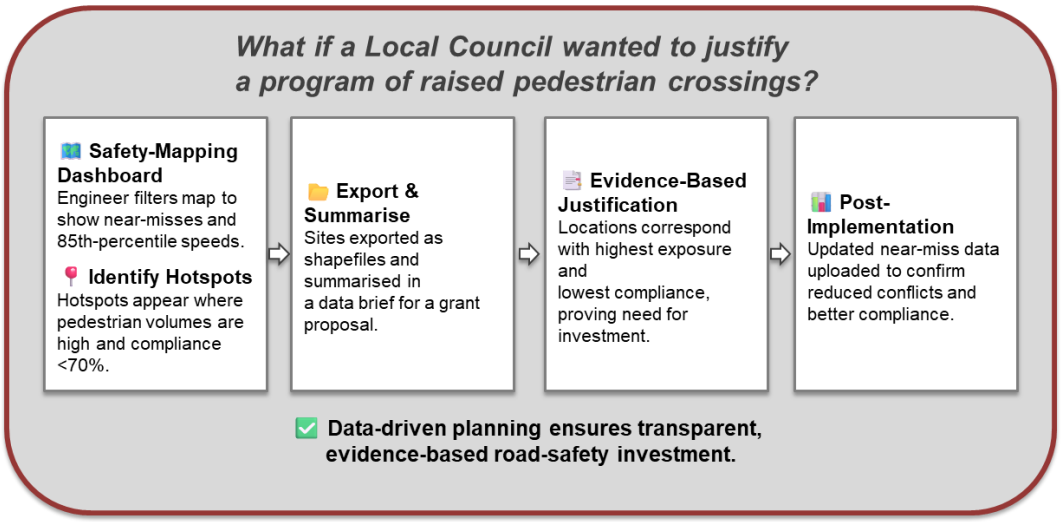


Figure 52: Potential application of the safety mapping tool

5.3.2 Crash Risk Assessment

The macroscopic crash risk assessment methodology combines recorded crash data with modelled walking and cycling volumes to produce exposure-normalised risk indices for every Local Government Area (LGA). Additional variables such as the length of separated cycleways and the proportion of low-speed environment roads (≤ 40km/h) capture the infrastructure context. This novel approach provides a user focussed assessment of crash risk in the context of active transport modes.

Key applications include:

- **Strategic safety investment planning**: Risk indices can be used to rank LGAs or corridors, directing limited funding toward locations where pedestrians and cyclists face the greatest harm potential relative to their activity levels.
- **Benchmarking and target setting**: Practitioners can compare local risk indices to regional or state averages to establish performance benchmarks and measurable improvement targets in road-safety action plans.
- **Scenario testing for design proposals**: During concept design, the model can estimate how proposed interventions (such as reducing operating speed or extending protected cycling lanes) affect crash risk per exposure unit, supporting cost–benefit assessments.
- **Policy and guideline integration**: TfNSW could embed crash-risk thresholds into Movement and Place assessments, automatically flagging high-risk corridors for review when exposure-normalised metrics exceed defined limits.

Figure 53 illustrates a hypothetical "what-if" scenario applying the crash risk assessment methodology developed in this report. In this example, Transport for NSW (TfNSW) is faced with the task of prioritising road safety funding, and the crash risk framework is used to demonstrate how data-driven assessment can inform and support investment decisions. Thus, exposure-based risk assessments offer practitioners to proactively identify safety concerns and quantify the benefits of design or policy interventions with statistical rigour.

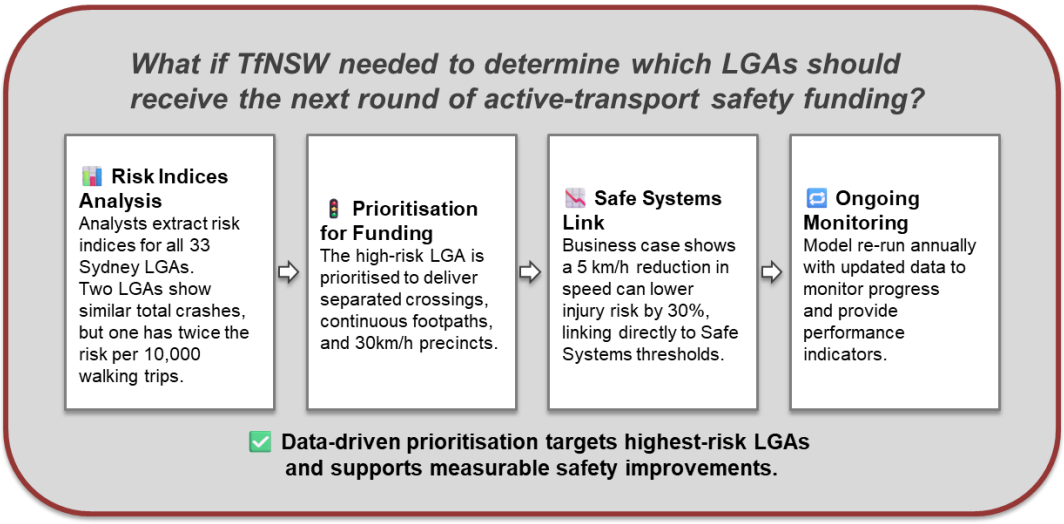


Figure 53: Potential application of the crash risk assessment methodology

5.3.3 Case Study Evaluation – Community Survey Tools

The intercept and online survey instruments developed through this project provide structured mechanisms for capturing user experience, perceived safety, and street functionality. The intercept survey gathers in-person feedback at specific sites, while the online survey can reach a broader audience for area-wide assessments. These tools offer practitioners an opportunity to engage with the community at different points of planning, designing and implementing changes to the road network.

Key applications include:

- **Before-and-after project evaluation**: Practitioners can deploy the intercept survey pre- and post-implementation to measure changes in perceived safety, comfort, and ease of performing key activities such as walking, relaxing, or cycling.
- **Network-level community engagement**: Councils can use the online survey to assess community readiness for area-wide 30 km/h precincts or shared-space applications, identifying precincts with the highest public support.
- **Design feedback and issue identification**: Survey results highlight recurring deficiencies (such as poor street furniture, limited cyclist facilities, or unsafe pedestrian–vehicle interactions) that can directly inform the "*Identify Issues and Opportunities*" stages of DORAS.
- **Triangulation with objective data**: Integrating perception data with observed traffic counts or speed data validates whether design intent aligns with user experience, highlighting gaps between measured and perceived safety.

Figure 54 presents a potential application of the community survey tools, depicting how a Local Council could use community feedback to inform the revitalisation of its main high street. Integrating structured survey methods within both DORAS and the NSW Speed Zoning Standard allows community perspectives to complement technical analysis, ensuring that design and safety decisions are grounded in evidence and aligned with the intent of both frameworks.

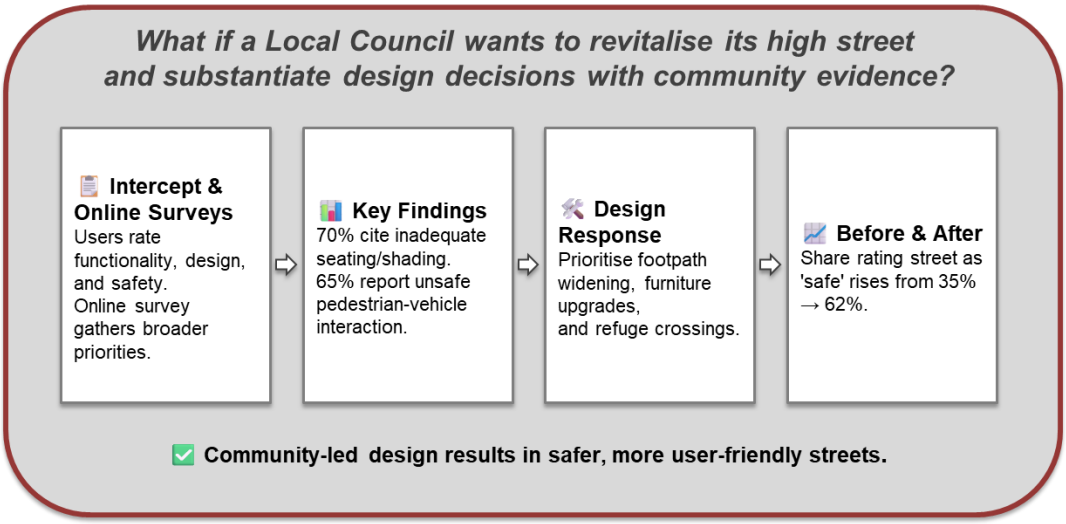


Figure 54: Potential application of the community survey tools

5.3.4 OLR Model Application

The **OLR models** developed in this study quantify how design attributes influence perceived safety for different user interactions. They allow practitioners to simulate how altering design components (street furniture, lighting, crossings, vegetation, or speed) changes the likelihood of users rating an environment as *Safe* or *Very Safe*.

To illustrate the potential application of the models, let's consider the ***Cyclist Interaction Model (Section 4.3.2.2)*** being applied to a local street without appropriate cycling infrastructure. The estimated model includes 38 variables, for this example we are assuming that only one of these variables will change. The focal variable is "Activity - Cycle" which measures how easy of hard it is to perform cycling on the street. This variable is rated on a six-point scale: "I don't know" (0), "Very hard to perform" (1), "Hard to perform" (2), "Neither hard nor easy" (3), "Easy to perform" (4), and "Very easy to perform" (5). The rating for "Activity - Cycle" was (2), "Hard to perform" on the local street. Following the implementation of a separated cycleway, the rating of the variable increase to (5) "Very easy to perform". The OLR model can be used to estimate the change safety perceptions across the categories of perceived safety as shown in Table 111. The results indicate that the introduction of the separated cycleway reduces the probability of perceiving the street as unsafe (from 82.9% to 64.9%) and increases the likelihood of more positive safety perceptions.

Table 111: Predicted probabilities of safety before and after the inclusion of a separated cycleway

	Activity_Cycle = 2	Activity_Cycle = 5
$P(Y = Unsafe)$	0.8292	0.6488
$P(Y = \text{Neither unsafe nor safe})$	0.1171	0.2216
$P(Y = \text{Safe})$	0.0464	0.1108
$P(Y = Very\ Safe)$	0.0073	0.0188

Therefore, the key applications of the OLR models include:

- **Design-option testing**: Practitioners can model alternative design configurations and estimate which option yields the largest improvement in perceived safety before committing to construction.
- **Investment prioritisation**: Elasticity values show which design variables have the greatest marginal impact, guiding resource allocation toward the most effective interventions.
- **Design validation and benchmarking**: Predicted probabilities can be compared with post-construction survey results to evaluate performance and refine future designs.
- **Policy and guideline calibration**: Aggregated model outcomes can inform weighting of safety and amenity indicators within future updates of DORAS and Movement and Place frameworks.

Figure 55 illustrates a scenario in which a designer must select features within a constrained budget. Using the OLR models, the designer can apply scenario modelling to assess the likely impacts of different design options. By translating subjective perception data into predictive probabilities, the models allow practitioners to anticipate how design choices may influence safety perceptions prior to implementation, enabling transparent and evidence-based decision making.

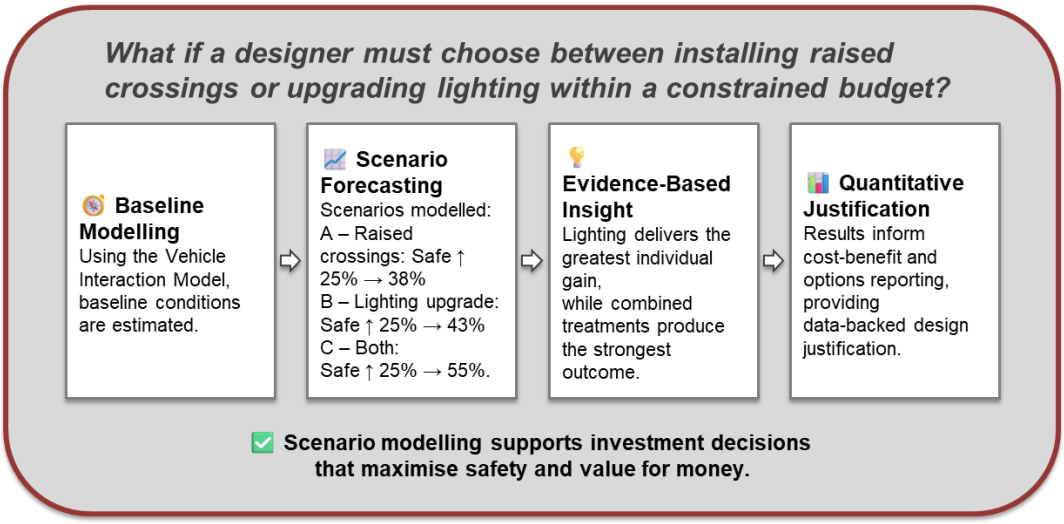


Figure 55: Potential application of the OLR model estimates

6 Concluding Remarks

This research has advanced the understanding of shared and low-speed environments through a comprehensive empirical investigation that combined macroscopic analysis across NSW with detailed case study evaluations. The research process involved the collation of multiple datasets, the development of metropolitan-scale safety and exposure database, and the collection of objective and subjective data at selected sites. The case study evaluations enabled the exploration of descriptive and text-based analyses. This was then extended to Ordered Logistic Regression statistical models that quantified the relationship between street functionality, design features, and perceived safety.

The key findings from the research can be summarised as follows:

- **Infrastructure and crash risk**: Areas with less active-transport infrastructure exhibit higher exposure-normalised crash risk, highlighting the measurable safety benefits of investment in pedestrian and cycling facilities.
- **Speed compliance**: Speed compliance was generally good across 30–40 km/h zones but was compromised at 10 km/h and 20 km/h limits, indicating that these very low-speed environments require stronger physical or visual design cues to communicate driver expectations.
- **Community acceptance**: Despite compliance challenges at very low limits, subjective data from both the intercept and online surveys showed strong community support for low-speed environments, with most respondents preferring that posted limits remain at or below current levels.
- **Subjective perception trends**: While site-specific differences emerged in the intercept surveys, the overall patterns of perception were consistent across the case study sites. Both survey modes identified similar priorities focussed on improving:
    - Street furniture
    - Cycling facilities
    - Pedestrian safety in relation to motor vehicles
- **Consistency in objective performance**: Objective datasets were broadly consistent across all sites, with expected variation by street type and between weekday and weekend conditions. This stability enhances the confidence in the comparability of results. Shared zones with 10km/h speed limits were the only locations that had speed compliance challenges. Combined with the macroscopic analysis, the speed limit or design options of this infrastructure should be reconsidered.
- **Design and behavioural insights**: The OLR models revealed that well-maintained streets, with strong environmental comfort and visible pedestrian features significantly improve perceived safety, while car-dominant layouts or poor cyclist facilities diminish it.

The findings reinforce that shared space road infrastructure can be successful when supported by designs that make safety intuitive. Traditional shared space principles rely on uncertainty, removing separating infrastructure to encourage caution from motor vehicle drivers' perspective, but this research and other recent studies (Batista, 2023; Theeuwes et al., 2024; Wijayaratna & da Rocha, 2025) show that **VRUs often feel intimidated in fully open environments**. Thus, a more effective design philosophy is one that creates **zones of protection within shared space environments** providing refuge and comfort for VRUs while clearly signalling to motorists that they are entering an environment of equal priority. As indicated in the literature review (Wijayaratna et al., 2022) and the practitioner engagement (Wijayaratna et al., 2024), there is a need to evolve the original definition of shared spaces, the empirical evidence from this project adds further support.

Practitioners may consider this approach as aligned with Local Area Traffic Management (LATM) practices, but it extends beyond them. As articulated in the *Austroads Guide to Traffic Management Part 8: Local Street Management*, LATM aims to "create safer and more pleasant streets in local areas" through system-based measures. Shared space designs are **a specific form of LATM that also seeks**

to equalise modal priority and enhance place quality, not simply calming traffic. Moving forward, shared spaces should embrace this duality of design: balancing safety and inclusion through subtle zoning and visual differentiation while maintaining the shared character that defines the typology.

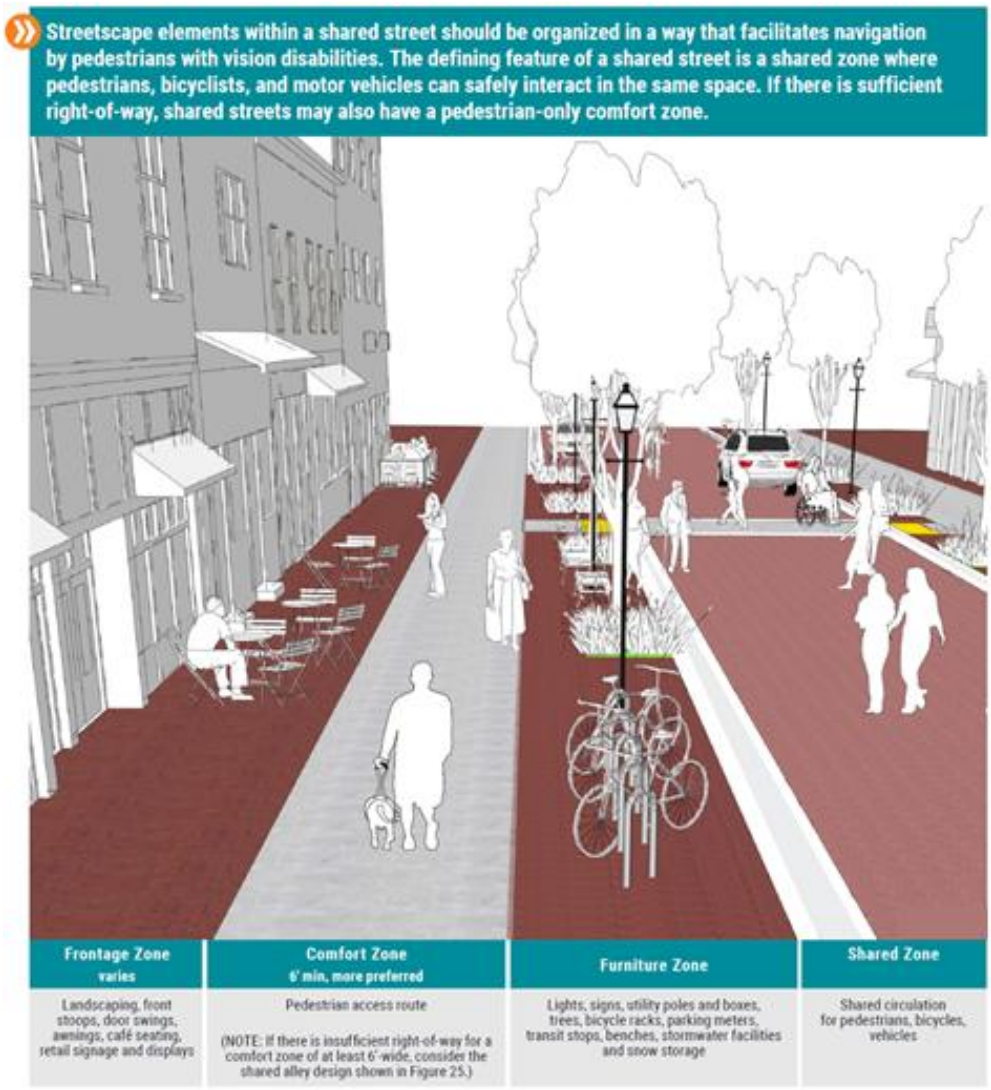


Figure 56: Zone based approach to shared space design(Elliot et al., 2017)

6.1 Limitations and Future Work

Though considerable advancements were possible in this research project there are several limitations and extensions possible. The following provides a summary of the main areas of improvement:

- **Data completeness**: The databases developed did not integrate public transport and land-use datasets due to limited accessibility. Including these would provide a more holistic understanding of mode interactions and spatial context.
- **Crash data scope and representativeness**: Crash data provides valuable post-event insights but is limited in proactive safety analysis, particularly as the case study sites in this research generally exhibited low crash frequencies. Future investigations should include shared environments with higher crash densities or identified safety black spots to better understand conditions linked to poor safety performance. As near-miss data becomes more widely available, it will offer a more proactive means of identifying and addressing risks before crashes occur.

- **Geographic coverage**: While the database was intended to be state-wide, low sample sizes of speed and near-miss data were present in regional areas, and walking and cycling volumes could not be reliably estimated outside the Greater Sydney region. Future work could prioritise on targeted data collection in regional areas which could provide further insights regarding this project and others.
- **User group perspectives**: The face-to-face survey primarily reflected pedestrian viewpoints, even though respondents were asked to consider multiple travel modes. Future work should include perception studies from motorists, cyclists, and motorcyclists, potentially through driving or cycling simulators.
- **Low-speed environment design**: Further research into the design and implementation of 10km/h and 20km/h zones can potentially improve driver compliance and reduce crash injury severity in these environments.
- **Scope of case studies**: Only 12 case study sites were analysed, all classified as shared or potential shared spaces. To develop comprehensive strategic guidance, further research should assess community perceptions across a broader range of street typologies defined in DORAS.
- **Advanced modelling**: The analysis focused on descriptive and direct models without exploring latent constructs. The dataset collected is rich enough to support structural equation modelling (SEM) in future stages (core objective of the upcoming project). This will enable the examination of indirect relationships and causal pathways between design, perception, and behaviour.

Building on the earlier stages of the ***UTS Shared Spaces Program***, this project has consolidated a growing body of work. Together, these efforts have established a repeatable framework for understanding how street design, speed environments, and user experience intersect. **However, to fully validate and operationalise the approaches developed to date, further work is required that moves beyond static analysis.** In addition to the limitations and extensions outlined above, future stages of the program should incorporate (as highlighted in Figure 57) simulation-based modelling to better represent the dynamic interactions between different modes within shared environments.

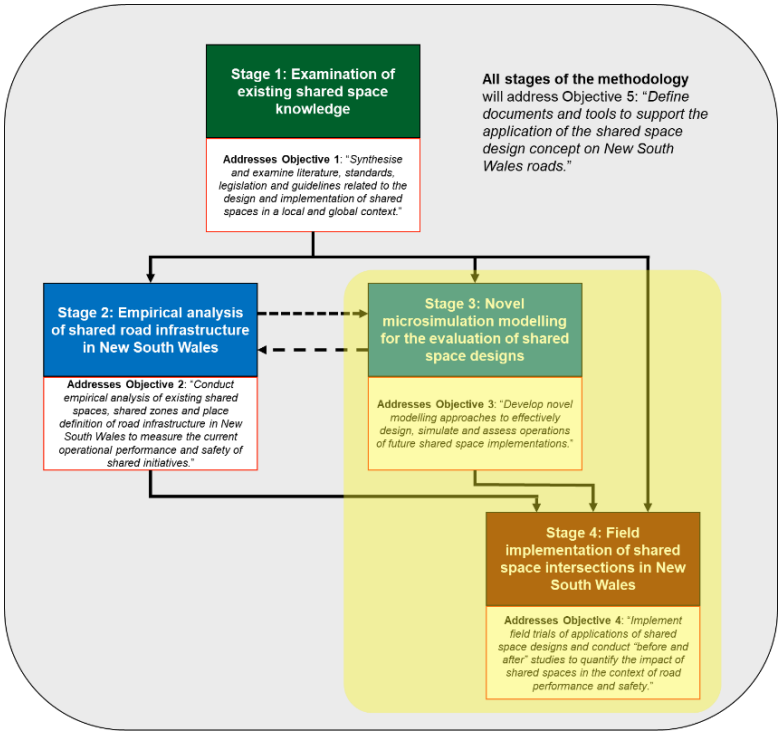


Figure 57: UTS Shared Spaces Research Program future stages

Agent-based or microsimulation approaches could quantify behavioural responses, such as yielding, speed adaptation, and conflict avoidance, under varying design and traffic conditions (Johora & Müller, 2020; Rinke et al., 2017; Slack-Smith et al., 2024). Equally important will be the implementation of before-and-after studies at new or retrofitted shared space sites. These longitudinal evaluations will allow empirical measurement of changes in speed, conflict frequency, and perceived safety, thereby validating the predictive models developed in this and previous stages. By linking real-world outcomes to simulated and statistical models, the program can move from correlation to causation, providing practitioners with confidence that design and policy interventions deliver measurable improvements in both safety and place outcomes.

6.2 Contribution and Impact

This research represents a major step forward in developing an empirical evidence base for shared and low-speed environments in New South Wales. It is the **first time that crash, speed, and near-miss data have been collated and correlated at a state scale**, creating an integrated macroscopic database that enables practitioners to quickly understand key safety relationships and identify emerging patterns. The exposure-based crash-risk modelling developed through this work also marks the **first Australian application of a framework that combines active-transport exposure estimates with crash data at the Local Government Area level**, providing a quantitative foundation for prioritising interventions and funding allocation.

Beyond these macroscopic advances, the project delivered the **first coordinated empirical data collection of shared street infrastructure in Australia including both objective and subject data**, extending earlier international work such as CIHT (2018) and offering context-specific evidence for design and policy decisions. **Novel analytical tools, including ordered logit regression (OLR) models and structured perception surveys. were developed to quantify aspects of the street environment that are rarely measured**, such as perceived safety, comfort, and environmental quality. These models allow practitioners and researchers to link subjective experience with objective street characteristics, providing a powerful mechanism for testing how design changes are likely to influence safety perceptions before implementation.

The project's outcomes have direct policy relevance. The datasets and models generated can be incorporated into future revisions of the NSW Design of Roads and Streets (DORAS) and the NSW Speed Zoning Standard, improving how safety, speed, and perception are assessed within planning and design processes. The macroscopic database and risk maps provide a platform for evidence-based decision-making, while the survey tools and modelling framework embed community perspectives and behavioural evidence into design evaluation.

Looking ahead, the next stage of research will build on this foundation by introducing latent-variable and structural-equation modelling (SEM) approaches. These techniques will enable deeper analysis of how subjective perceptions, design quality, and traffic conditions interact, revealing indirect relationships that cannot be captured through direct regression alone. Following the SEM modelling, Stages 3 and 4 will use simulation tools and before-and-after studies to validate, generalise and operationalise these findings. Such advancements are crucial for the development of a genuinely evidence-driven, human-centred approach to street design and speed management—ensuring that NSW remains a national leader in creating safer, more inclusive, and more liveable public spaces.

These contributions demonstrate how shared space design in NSW can evolve into a measurable, evidence-based practice. The integration of objective and subjective data, coupled with advanced analytical modelling, provides practitioners with a new level of precision in assessing safety, comfort, and performance. The research outcomes presented in this report lay the groundwork for continued refinement of policy and design guidance. This will ensure that future streets not only minimise harm, but also foster equitable, inclusive, and vibrant public spaces that reflect the needs of all users.

7 References

Ambros, J., Turek, R., Šragová, E., Petr, K., Šucha, M., & Frič, J. (2021). How fast would you (or should you) drive here? Investigation of relationships between official speed limit, perceived speed limit, and preferred speed. *Transportation Research Part F: Traffic Psychology and Behaviour*, *83*, 164-178.

Australian Bureau of Statistics. (2022). *Census of Population and Housing, 2021*. https://www.abs.gov.au/census

Barrett, P., Zhang, Y., Moffat, J., & Kobbacy, K. (2013). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning. *Building and Environment*, *59*, 678-689.

Basaran, G. G., Kristoffersen, D., & Haustein, S. (2021). Safety perceptions and cycling frequency of highly educated young people who grew up in different mobility cultures. *Active Travel Studies*, *1*(1).

Batista, M. (2023). *Plurality of Shared Space Design: Exploring the Influence on Road Users* Dissertation, Braunschweig, Technische Universität Braunschweig, 2023].

Batista, M., Berghoefer, F. L., & Friedrich, B. (2023). Exploring pedestrian and cyclist preferences for shared space design: A video-based online survey. *Transportation Research Interdisciplinary Perspectives*, *22*, 100976.

Batista, M., & Friedrich, B. (2022). Investigating spatial behaviour in different types of shared space. *Transportation Research Procedia*, *60*, 44-51.

Cascajo, R., Lopez, E., Herrero, F., & Monzon, A. (2019). User perception of transfers in multimodal urban trips: A qualitative study. *International Journal of Sustainable Transportation*, *13*(6), 393-406.

Castilla, N., Blanca-Giménez, V., Pérez-Carramiñana, C., & Llinares, C. (2024). The Influence of the Public Lighting Environment on Local Residents' Subjective Assessment. *Applied Sciences*, *14*(3), 1234.

Centre for Road Safety: Transport for NSW. (2024). *Road Traffic Casualty Crashes in New South Wales (Statistical Statement for the year ended 31 December 2023)*. Sydney, NSW: NSW Government Retrieved from https://www.transport.nsw.gov.au/system/files/media/documents/2024/crs_crashstats_2023.pdf

Centre for Road Safety: Transport for NSW. (2025). *Monthly bulletin of preliminary traffic crash data - September 2025*. Sydney, NSW: NSW Government Retrieved from https://www.transport.nsw.gov.au/system/files/media/documents/2025/mbsep2025_01102025.pdf

CIHT. (2018). *Creating better streets: Inclusive and accessible places - Reviewing shared space*. Chartered Institution of Highways and Transportation.

City of Sydney. (2024). *Improving Loftus Street, Customs House Lane and Reiby Place, Sydney*. City of Sydney,. Retrieved 10 September 2024 from https://www.cityofsydney.nsw.gov.au/improving-streets-public-spaces/improving-loftus-street-customs-house-lane-reiby-place

Elliot, J., Lohse, K., Toole, J., Lockwood, I., Barlow, J., Bentzen, B., & Porter, C. (2017). *Accessible Shared Streets - Notable practices and considerations for accommodating pedestrians with vision disabilities*. US Department of Transportation Federal Highways Administration.

Goldenbeld, C., & van Schagen, I. (2007). The credibility of speed limits on 80 km/h rural roads: The effects of road and person (ality) characteristics. *Accident Analysis & Prevention*, *39*(6), 1121-1130.

Green, D., Lewis, K., Ward, J., & Munro, C. (2020). *Austroads Guide to Traffic Management: Part 8: Local Street Management* (1925854825).

Hamilton-Baillie, B. (2008). Shared space: Reconciling people, places and traffic. *Built environment*, *34*(2), 161-181.

Johora, F. T., & Müller, J. P. (2020). Zone-specific interaction modeling of pedestrians and cars in shared spaces. *Transportation Research Procedia*, *47*, 251-258.
Karndacharuk, A., & McTiernan, D. (2019). Implementation principles for 30 km/h speed limits and zones. *Journal of Road Safety*, *30*(2), 45-54.
Karndacharuk, A., Wilson, D. J., & Dunn, R. C. M. (2013). Evaluating shared spaces: Methodological framework and performance index [Review]. *Road and Transport Research*, *22*(2), 52-61. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84898411309&partnerID=40&md5=ef531791d3f95b8a9637fadc3897af76
Law, P. C., San Too, L., Spittal, M. J., Pirkis, J., & Clapperton, A. J. (2024). Road vehicle collision suicide in Australia: Trends, collision types, and individual characteristics. *PloS one*, *19*(4), e0299590.
Llinares, C., Higuera-Trujillo, J. L., Montañana, A., & Castilla, N. (2020). Improving the pedestrian's perceptions of safety on street crossings. Psychological and neurophysiological effects of traffic lanes, artificial lighting, and vegetation. *International journal of environmental research and public health*, *17*(22), 8576.
Mahmoud, N., Abdel-Aty, M., & Abdelraouf, A. (2023). The impact of target speed on pedestrian, bike, and speeding crash frequencies. *Accident Analysis & Prevention*, *192*, 107263.
Milton, K., Kelly, M. P., Baker, G., Cleland, C., Cope, A., Craig, N., Foster, C., Hunter, R., Kee, F., & Kelly, P. (2021). Use of natural experimental studies to evaluate 20mph speed limits in two major UK cities. *Journal of Transport & Health*, *22*, 101141.
Montgomery, D. C., & Runger, G. C. (2010). *Applied statistics and probability for engineers*. John wiley & sons.
Müggenburg, H., Blitz, A., & Lanzendorf, M. (2022). What is a good design for a cycle street?–User perceptions of safety and attractiveness of different street layouts. *Case studies on transport policy*, *10*(2), 1375-1387.
Nightingale, G. F., Williams, A. J., Hunter, R. F., Woodcock, J., Turner, K., Cleland, C. L., Baker, G., Kelly, M., Cope, A., & Kee, F. (2021). Evaluating the citywide Edinburgh 20mph speed limit intervention effects on traffic speed and volume: A pre-post observational evaluation. *PloS one*, *16*(12), e0261383.
NSW Government. (2023a). *Design of roads and streets: A guide to improve the quality of roads and streets in NSW*. NSW Government
NSW Government. (2023b). *Safer Cities Survey Report: Perceptions of safety in public spaces and transport hubs across NSW*. Sydney, Australia: NSW Government Retrieved from https://www.transport.nsw.gov.au/system/files/media/documents/2023/Safer-Cities_Survey-Report_0.pdf
NSW Government. (2024a). *Design of Road and Streets Guide*. Retrieved 10 September 2024 from https://www.movementandplace.nsw.gov.au/design-principles/design-road-and-streets-guid
NSW Government. (2024b). *Great Places Toolkit*. NSW Government,. Retrieved 24 October 2024 from https://www.transport.nsw.gov.au/industry/cities-and-active-transport/place-and-precinct-revitalisation/great-places-toolkit
NSW Government. (2025a). NSW Speed Zoning Standard. In *Speed and fatality risk*.
NSW Government. (2025b). NSW Speed Zoning Standard TS 03631:2.0. In. Sydney, Australia: NSW Government.
Pearson, L., Oakey, M., Nelson, B., Karbakhsh, M., Karmali, S., & Beck, B. (2025). Cross-country policy comparison of 30 km/h speed limits. *Cities & Health*, 1-12.
Powers, D., & Xie, Y. (2008). *Statistical methods for categorical data analysis*. Emerald Group Publishing.
Qin, P., He, J., Zhang, C., Yan, X., Wang, C., Ye, Y., & Fang, Z. (2025). Crash risk prediction and analysis from the perspective of alignment and environment features: A study on an expressway in a hilly area. *Traffic Injury Prevention*, 1-11.
Quercia, D., Schifanella, R., & Aiello, L. M. (2014). The shortest path to happiness: Recommending beautiful, quiet, and happy routes in the city. Proceedings of the 25th ACM conference on Hypertext and social media,

Rinke, N., Schiermeyer, C., Pascucci, F., Berkhahn, V., & Friedrich, B. (2017). A multi-layer social force approach to model interactions in shared spaces using collision prediction. *Transportation Research Procedia*, *25*, 1249-1267.

Rossetti, T., Lobel, H., Rocco, V., & Hurtubia, R. (2019). Explaining subjective perceptions of public spaces as a function of the built environment: A massive data approach. *Landscape and urban planning*, *181*, 169-178.

Saberi, M., & Lilasathapornkit, T. (2024). Scalability challenges of machine learning models for estimating walking and cycling volumes in large networks. *npj Sustainable Mobility and Transport*, *1*(1), 8.

Singh, S., & Sagar, R. (2021). A critical look at online survey or questionnaire-based research studies during COVID-19. *Asian Journal of Psychiatry*, *65*, 102850.

Slack-Smith, D., Wijayaratna, K. P., & Zeibots, M. (2024). The Development of Modeling Shared Spaces to Support Sustainable Transport Systems: Introduction to the Integrated Pedestrian–Vehicle Model (IPVM). *Sustainability*, *16*(10), 4227.

Stichler, J. F., & Hamilton, D. K. (2008). Evidence-based design: What is it? *HERD: Health Environments Research & Design Journal*, *1*(2), 3-4.

TfNSW. (2023). *NSW Road Safety Progress Report 2023*.

Theeuwes, J., Snell, J., Koning, T., & Bucker, B. (2024). Self-Explaining Roads: Effects of road design on speed choice. *Transportation Research Part F: Traffic Psychology and Behaviour*, *102*, 335-361.

Tottadi, K. K., & Mehar, A. (2022). Operating speed: review and recommendations for future research. *Innovative infrastructure solutions*, *7*(1), 67.

van Erpecum, C.-P. L., Bornioli, A., Cleland, C., Jones, S., Davis, A., den Braver, N. R., & Pilkington, P. (2024). 20 mph speed limits: A meta-narrative evidence synthesis of the public health evidence. In *Advances in Transport Policy and Planning* (Vol. 13, pp. 167-195). Elsevier.

Wang, X., Zhou, Q., Quddus, M., Fan, T., & Fang, S. e. (2018). Speed, speed variation and crash relationships for urban arterials. *Accident Analysis & Prevention*, *113*, 236-243.

Wijayaratna, K., & da Rocha, C. (2025). Leveraging Lego Serious Play® in Examining Practitioner Perspectives of Shared Spaces. *Transportation research record*, 03611981251341357.

Wijayaratna, K., da Rocha, C., Tran, A., & Bradbury, N. (2024). *Evaluation and Implementation of Shared Spaces in NSW: Empirical analysis of Shared Road Infrastructure* Sydney, Australia: NSW Government,

Wijayaratna, K., da Rocha, C., Zeibots, M., Bradbury, N., & Nishandar, N. (2022). *Evaluation and Implementation of Shared Spaces in NSW: Framework for road infrastructure design and operations to establish placemaking Examination of existing Shared Space knowledge*. Sydney, Australia: NSW Government

Williamson, A. (2021). Why do we make safe behaviour so hard for drivers? *Journal of Road Safety*, *32*(1), 24-36.

Wramborg, P. (2005). A new approach to a safe and sustainable road structure and street design for urban areas. Road Safety on Four Continents: 13th International ConferenceSwedish National Road and Transport Research Institute (VTI) Ministry of Infrastructure, PolandGlobal Road Safety PartnershipForum of European Road Safety Research InstitutesEuropean Conference of Transport Research InstitutesTransportation Research BoardCouncil for Scientific and Industrial ResearchNational Road Safety Council, Poland,

Yannis, G., & Michelaraki, E. (2025). Effectiveness of 30 km/h speed limit–A literature review. *Journal of Safety Research*, *92*, 490-503.

Yasmin, S., Eluru, N., Wang, L., & Abdel-Aty, M. A. (2018). A joint framework for static and real-time crash risk analysis. *Analytic methods in accident research*, *18*, 45-56.

Zhang, Y., Tzortzopoulos, P., & Kagioglou, M. (2019). Healing built-environment effects on health outcomes: Environment–occupant–health framework. *Building research & information*, *47*(6), 747-766.