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The road safety and multi-modal impacts of on-street parking

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Abstract

On-street parking is a coveted asset on many streets, yet it occupies a significant share of space that could otherwise support wider footpaths, cycle paths, outdoor seating, street trees, or dedicated lanes for traffic or public transport. While the spatial implications of on-street parking are well understood, its impact on road safety is less well-understood.

This research, commissioned by NZ Transport Agency Waka Kotahi, addresses this gap by exploring road safety impacts of on-street parking in urban areas. It includes a review of existing New Zealand and international literature, planning and design guidelines, and analysis of New Zealand crash data from 2017-2021 (inclusive). Parked cars or the act of parking were involved in 7.7% of all reported crashes and 2.5% of all death or serious injury (DSI) crashes over the five-year period 2017-2021 (inclusive). Most DSI crashes involved collisions with parked cars, often due to factors like loss of control, visibility being obscured (e.g., sunstrike or fog), inattentive driving, medical events, or fatigue.

Vulnerable road users (pedestrians, cyclists and motorcyclists) accounted for nearly half of all serious injuries and over two-thirds of deaths in parking related crashes. While on-street parking can offer some benefits such as traffic calming, it may also negatively impact the accessibility of bus operations or safety of vulnerable road users.

The research provides recommendations across regulation, driver behaviour, safety campaigns, design guidance and crash data collection to address on-street parking related safety issues to support improved multi-modal outcomes.

This paper is submitted as a Research Paper.

1 Introduction

Over the last century, many streets have been designed around the increasing prevalence of private vehicle movement and parking. With limited space in our road corridors, achieving multi-modal outcomes (i.e catering for a range of travel modes) often involves road space reallocation in existing streets. On-street parking is sometimes removed, and other uses of that space are prioritised, such wider footpaths, cycle facilities, bus lanes and amenity improvements. Often, there is public resistance to reducing or changing on-street parking. This resistance can create challenges in delivering multi-modal outcomes and result in negative safety impacts when parking is retained or provided in a suboptimal way. Figure 1 shows an example of a recent street upgrade and conversion to a one-way shared space street, where more on-street parking than is desirable for this type of street was retained due to stakeholder feedback.

Figure 1 - On-street parking retained in a recent shared space street upgrade

Despite growing road safety data, there is little aggregated data and published research that specifically and comprehensively focuses on how parking affects the safety of other travel modes. This study, commissioned by New Zealand Transport Agency Waka Kotahi (NZTA) addresses this gap by examining how on-street parking can impact multi-modal safety outcomes (Ward et al, 2024). It also examines strategies to mitigate adverse effects and contribute to positive outcomes.

Using a Safe System approach, the research focuses on reducing deaths and serious injuries, while also acknowledging the role of minor injuries, perceived safety, and accessibility (e.g., parked cars blocking footpaths). Note that the safety discussed in this research pertains solely to road safety, rather than personal security issues.

The scope of the research is limited to urban on-street parking and does not include off-street parking, which has different types of risks and management practices. It does not cover detailed parking management strategies, economic considerations of parking locations or provide advice on optimal use of kerb side space. However, it is acknowledged that some aspects of parking management, such as reducing search time for parking can enhance safety by reducing conflict risks.

This paper presents key research findings and provides practical advice to transport planners and designers. NOTE: The research was conducted under the 2021-24 Government Policy Statement for Land Transport. Some referenced policies and initiatives may now be concluded or repealed.

2 Research method

To provide context, the study began with an overview of how on-street parking is legislated, designed and managed in New Zealand. This included the legal framework under which on-street parking is provided, aspects of law relevant to multi-modal outcomes, and the broader parking policy and management environment.

A literature review examined New Zealand and international research on the relationship between on-street parking, safety, and multi-modal outcomes. It also reviewed design guidance to understand current provisions for mitigating associated issues.

The safety analysis focused on identifying relationships between crash risks and specific parking layouts. This involved interrogation of the NZTA Crash Analysis System (CAS) data and relevant Accident Compensation Corporation (ACC) data to capture crashes not included in CAS but clearly linked to on-street parking. While CAS includes codes for parking manoeuvres and collisions with parked vehicles, it does not consistently code crashes that are indirectly related to parking such as those involving visibility obstructions caused by parked

cars near intersections or driveways. The analysis was particularly focused on death and serious injury (DSI) outcomes.

The study also examined how parking is laid out across New Zealand streets, the rationale behind different configurations, and key features influencing those arrangements. This was considered in relation to the One Network Framework (ONF) urban street types (NZTA, n.d (b)) and the Speed Management Guide (NZTA, 2022a). The advantages and disadvantages of various layouts were compiled, along with insights into how road controlling authorities select layout options. Literature and crash analysis findings were used to assess the safety implications of each layout type, both positive and negative, and to identify any innovative practices currently in use.

The research identified existing safety and design strategies to mitigate risks associated with various parking layouts, and recommended improvements or new approaches where appropriate. The findings were summarised in tables outlining mitigation strategies tailored to each travel mode.

Brief case studies of street design projects were developed to examine real-world examples where road space allocation decisions involved on-street parking. These focused on higher volume roads, where safety risks tend to be greater, and highlighted how design changes influenced outcomes. Recommendations were provided to show how the strategies developed could assist in similar contexts.

3 The New Zealand context

3.1 Parking policy and management

Effective parking policy supports safer, more multi-modal streets. For example, prioritising parking types by location can free up road space for other purposes, such as landscaping or cycle facilities. Measures that reduce the time spent searching for parking can also reduce circulating vehicles, lowering risks to other road users, including from distracted drivers focused on finding a space.

Road Controlling Authorities (RCAs) develop their own parking policies and management plans. The National Parking Management Guidance (NZTA, 2021) offers best-practice advice for managing public parking across New Zealand. While not a design guide, it recognises that well-managed parking can contribute to vibrant, safe, urban environments. Conversely, poor parking design and oversight can create hazards for pedestrians and cyclists and undermine urban livability.

3.2 Operational management of on-street parking

RCAs oversee on-street parking, including time restrictions and designated uses such as bus stops, mobility spaces, loading zones, and taxi stands. Each use has specific design needs, like width and length, and step free access for mobility parking. These requirements are generally well defined by existing standards.

Parking regulations are governed by a combination of national legislation and local bylaws. The Land Transport Act 1998 and Land Transport (Road User) Rule 2004 set general rules and enforcement powers. RCAs such as local councils, adopt bylaws under the Local Government Act 2002 and the Land Transport Act 1998, which may include specific restrictions such as prohibiting parking on berms adjacent to kerbs. These bylaws are enforced by RCA-appointed officers who may issue infringement notices or arrange for vehicles to be towed by authorised contractors.

At the time of the research, parking fines were low and had remained unchanged since 2004, potentially contributing to notable non-compliance. To address this, in October 2024 the Government implemented a nationwide increase by amending the Land Transport (Offences and Penalties) Regulations 1999 to increase fines by approximately 70%. However, enforcement remains essential to ensuring compliance.

3.3 On-street parking layouts

In New Zealand, on-street parking is usually configured either parallel to the kerb or road edge, or at an angle ranging from 30 to 90 degrees. Some streets may have parallel parking on one side and angle parking on the other side. On very wide streets, angle parking may also be located in the centre of the road.

Parking, both parallel and angle, can be indented between kerb buildouts. This configuration offers several benefits. When parking spaces are vacant, the perceived street width is reduced, which can discourage excessive vehicle speeds. Kerb buildouts also enhance pedestrian safety by shortening crossing distances and improving sightlines between drivers and pedestrians. Additionally, these areas support placemaking initiatives, such as landscaping, seating, and cycle parking.

Examples of the typical parking configurations are shown below in Figures 2 to 5.

Figure 2 – Parallel parking on both sides (Nelson)

Figure 3 – Angle parking on both sides (Nelson)

Figure 4 – Angle parking on one side, parallel parking on the other (Marton)

Figure 5 – Angle parking on the side (60°) and centre of the road (60°) (Fielding)

4 The impacts of on-street parking

4.1 Overview

There is evidence that on-street parking can impact safety and multi-modal outcomes. Biswas et al. (2017) conducted a comprehensive review of the effects of on-street parking, both positive and negative, examining impacts on safety, traffic and the local economy. Their work synthesises a broad range of literature on the topic. A separate review by Sisiopiku (2001) reached similar conclusions. These reviews found that the main safety and multi-modal impacts of on-street parking were:

- Traffic calming function – potential positive effect
- Buffer between pedestrians on the footpath and moving vehicles – potential positive effect
- Can cause crashes – definitive negative effect
- Deterrent to active modes – potential negative effect

4.2 Traffic calming

Praburam and Koorey (2015) studied ten residential streets in Christchurch (50 km/h speed limits; 8-13m wide). They found that parking occupancy correlated with lower vehicle speeds, estimating a 1 km/h speed reduction per 10% increase in occupancy. Speed reductions were more pronounced on wider streets. While crash data was not assessed, the study supports the concept that parked vehicles reduces perceived (optical) road width, influencing driver speed (Lindenmann, 2007).

Marshall et al. (2008) found lower injury crash rates in low-speed environments (<56 km/h) with on-street parking compared to those with no parking. This suggested that drivers adjusted to increased complexity of the environment. However, higher speed areas, on-street parking was linked to increased crash rates.

4.3 Buffer for pedestrians

Compared to bicyclist safety, pedestrian safety impacts of on-street parking have received less research attention. Some studies suggest a generally negative association between on-street parking and pedestrian safety or perceived safety. None of the reviewed literature indicated that pedestrians view parked cars as a buffer from moving traffic. However, one design guide (Auckland Transport, n.d.) noted that parallel parking can provide a buffer, likely linked to footpath width. For instance, a narrow footpath, (less than 2m) beside traffic moving at 50km/hour, can feel very uncomfortable, and parked cars may improve perceived comfort.

4.4 Crashes

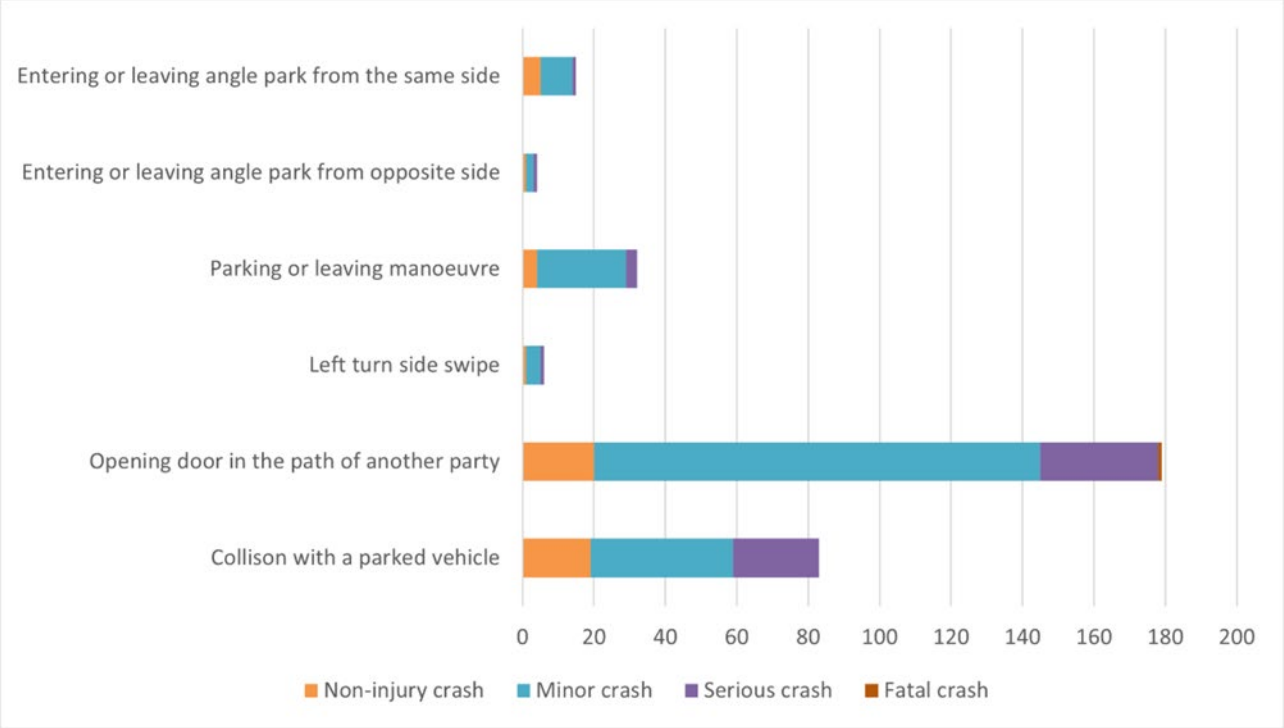
Interrogation of NZTA Crash Analysis System data from 2017 and 2021 (inclusive) found 14,030 urban crashes involving parked cars or the act of parking. This represents 7.7% of all reported crashes during that period and 2.5% of all DSIs. These included nine fatal and 286 serious injury crashes, which are shown by travel mode in Table 1.

Table 1 – DSI crashes by mode

Injury Severity	Pedestrian	Cyclist	Motorcyclists/mopeds	Car occupants
DSI	40 (13% of DSIs)	73 (25% of DSIs)	32 (11% of DSIs)	150 (51% of DSIs)

Most DSI crashes involved vehicles colliding with parked cars, often due to loss of control, poor visibility (for example, from sunstrike or fog), or driving inattention. Some were linked to driver medical events or falling asleep. Vulnerable road users (pedestrians, cyclists and motorcyclists) accounted for nearly half of all serious injuries and over two-thirds of deaths in parking related crashes. Cyclists had the highest DSI rate among vulnerable road user groups. See Figure 6 for the breakdown of the parking-cyclist related crashes.

Figure 6 – Parking related crashes involving cyclists, 2017–2021



Determining how often crashes occur due to parked vehicles obstructing visibility at intersections, driveways, or crossings, is difficult due to the varied crash codes used. Moreover, this type of crash is likely under-reported. ViaStrada (2021) contends that due to CAS under-reporting, actual serious injury numbers may be more than double the reported amount. One serious crash examined involved a one-way separated cycle path with parallel parking between the cycle path and traffic: a driver turning left into a driveway failed to see a cyclist due to parked vehicles blocking the view. As separated cycle paths are relatively new in New Zealand, limited crash data was expected at the time of research.

To supplement CAS data, ACC injury claim data related to parking was also requested for the 2017 – 2021 (inclusive) period. However, a key limitation was the inability to distinguish between on-street and off-street parking incidents. Additionally, the nature of the data extraction process introduced a risk of false. Overall, the ACC data showed limited alignment with CAS records.

Despite data limitations, several clear causes for parking related DSI outcomes in New Zealand were identified. These offer potential focus areas for improving street design, management, and influencing driver behaviour. The key DSI outcomes are:

- Car door opening into cyclist's path
- Cyclists colliding with parked cars
- Pedestrian crossing the road from the driver's left side and being struck by the vehicle.

4.5 Crashes - Dooring crashes

It is clear from both literature and crash data that car door opening into the path of cyclists is the main cause of cycle / parking related crashes and has the highest proportion of DSI outcomes. Available data from a range of jurisdictions (USA, Canada, Australia) suggests that car dooring crashes account for about 12% to 27% of all bicycle-motor vehicle crashes (Schimek, 2018). Most of the New Zealand crashes were due to the door hitting the cyclist and knocking them off their bike, usually into the traffic lane.

The CAS dooring crash data were compared with the findings of The University of Otago Injury Prevention Research Unit (IPRU) demonstration project that resulted in a New Zealand cyclist / dooring map (Injury Prevention Research Unit, n.d.). The purpose of the IPRU project was to determine the feasibility of developing and displaying a publicly accessible interactive web-based map of police reported dooring-related bicycle injuries among New Zealand cyclists.

IPRU used the 2007 to 2011 CAS data and found that 245 cycle dooring injuries were reported in New Zealand (mean = 49/year). These represented 6% of all cyclist injuries involving motor vehicles. They found this compared to 19.4% in Victoria, Australia. The 2017 to 2021 CAS data featured 180 dooring crashes.

The literature generally recommended reconfiguring road space to allow for wider bicycle lanes or shifting the lane to the kerb side of parking. Figure 7 shows a layout that increases the risk of dooring (extension of the no-stopping lines would improve the situation), and a design where the cycle lane is on the kerb side of parking, removing the dooring risk.

Figure 7 – Cycle lane / parking layout with high dooring risk (left) and layout that removes dooring risk (right)

4.6 Crashes - Cyclists colliding with parked cars

A cyclist colliding with a parked vehicle was also a clear crash type. Some of these crashes included illegally parked cars (e.g., cars parked in cycle lanes), parking near bends or intersections, cyclists being distracted/sunstrike, handlebars clipping wing mirrors and taking evasive action. Although there are a range of factors in this crash type, it is important in the design of streets that layouts do not increase the risk of cyclists colliding with parked cars. Figure 8 shows an example of a layout that may increase the risk of a cyclist colliding with a parked car due to the termination of the cycle lane and cyclists being required to merge into the traffic lane over a short length.

Figure 8 – Layout that may increase risk of cyclist colliding with a parked car

4.7 Crashes – Pedestrians crossing the road

The highest proportion of parking-pedestrian related crashes involved pedestrians crossing the road, specifically pedestrians struck when emerging on the driver's left side. Parked cars can potentially obstruct a driver's view of pedestrians attempting to cross. The data did not always state whether the crash occurred at a formal pedestrian crossing facility. Many of the pedestrians in these crashes (particularly serious crashes) were children and many were near a school where buses and cars are parked on the street at the end of the school day.

Parked vehicles can obstruct the view of oncoming vehicles. Some were related to parked cars being too close to pedestrian crossings. Some crashes occurred when a person was trying to get into the vehicle from the traffic side and was hit by a passing vehicle travelling too far left. Over time the New Zealand vehicle fleet has seen an increase in SUVs and UTEs, which are approximately 300mm higher than sedans. This increased vehicle height may contribute to reduced visibility when such vehicles are parked near intersections or pedestrian crossings.

In the case of formal crossing locations, the design can ensure visibility is not obscured. Figure 9 shows an example of an appropriate no-stopping restriction on approach to the crossing that allows good forward visibility of people about to use the crossing. Where people cross between parked cars, lower speed environments will help reduce the injury severity if a crash were to occur.

Figure 9 – Appropriate no-stopping restriction on approach to crossing

4.8 Detering people from cycling

A study sought to understand how New Zealand cyclists perceive the levels of service provided by different types of cycling infrastructure, considering complex external factors such as motor vehicle traffic, land use, hills and environmental conditions (Bowie et al., 2019). Another objective of the study was to provide a user-centred approach for assessing existing and proposed facilities, thereby supporting better-informed decisions regarding target cycling levels of service and key factors to manage in the planning and design of cycle facilities in New Zealand. Through a series of user surveys, the study found that even when riders rated road sections with a relatively high level of service based on the experience they had on the day of their ride, they often included comments about the danger of car doors opening, vehicles being stopped in the cycle lane, and cars entering and leaving parking spaces. Other literature (e.g Mackie et al., 2017) reported that the risk from parking deterred people from cycling.

4.9 Detering people from walking

A vehicle parked on the footpath or in a driveway can block the footpath and require footpath users to detour around this obstacle, this is difficult for someone with a mobility device. Figure 9 shows an example of driveway parking blocking the entire footpath. Parking in this manner is covered by the Road User Rule (clause 6.14) which states that a driver or person in charge of a vehicle must not stop, stand, or park the vehicle on a footpath or on a cycle path. However, this is unlikely to be enforced unless someone makes a complaint.

There is no consolidated New Zealand data on how often this occurs and what measurable impact it has on deterring people from walking. Social media posts in community forums observed by the authors indicate this type of parking infringement is a regular occurrence.

Figure 9 - Driveway parking blocking footpath

5 Factors to consider when providing on-street parking

Based on the findings of the literature review and safety analysis, it was concluded that when designing or configuring a street layout, there are a range of aspects to consider that can impact on the parking supply, management and design decisions. The supply decision is generally associated with a Parking Management Plan for the area. If parking is to be provided, the key layout aspects to consider are the role of the street (movement and place), speed environment, and external factors. External factors may include stakeholder influence during the design process, which can affect parking design decisions in terms of both supply and layout. Table 2 outlines the advantages and disadvantages of various parking layouts that need to be considered when determining the parking layout for a street.

Table 2 Advantages and disadvantages of parking layouts that inform decision making

Parking type	Advantage	Disadvantage
Parallel parking	Has less disruption on flow of traffic Has fewer crashes associated with manoeuvring out of parking spaces than angle parking	Accommodates fewer spaces along the kerb edge than angle parking Creates a car door opening risk to cyclists on the road, pedestrians on the footpath, or pedestrians and cyclists on shared paths
Angle parking – 90 degrees	Provides more spaces than parallel parking Can access the spaces from both traffic directions Services more spaces per paid parking terminal if using walking distance as a parameter	Roadway width needs to be able to accommodate spaces Not suitable next to a cycle lane unless there is an adequate buffer for parking manoeuvres Crash risks when vehicles exit, whether there is a cycle lane or not
Angle parking – 30-60 degrees	Provides more spaces than parallel parking Works better on a one-way street than a two-way street due to direction of access and egress	Roadway width needs to be able to accommodate spaces, this can mean that parking is only feasible on one side of the road Depending on angle, it may be difficult for drivers parked to enter the traffic stream. Not suitable next to a cycle lane unless there is an adequate buffer for parking manoeuvres Crash risks when vehicles exit
Reverse in angle parking	Reduces the risk to cyclists passing behind the parking as drivers facing the road (but a buffer still recommended) Safer for drivers and passengers accessing the rear of the vehicle, such as for loading/unloading prams/young children, shopping, etc.	This type of parking is uncommon in New Zealand and therefore may not be familiar to road users.
Angle parking in middle of the road (usually 90 degree)	Can help create a traffic calming effect but needs landscaping at intervals so that when spaces are empty the road width does not look excessively wide Allows access from both directions of traffic	Requires very wide road reserve Should not be used on arterial roads Pedestrians have to cross one carriageway when leaving and returning to the vehicle. Crash risks when vehicles exit

6 Strategies to improve safety

6.1 Overview

The research identified that designs removing parking to achieve positive road safety and multi-modal outcomes are often compromised by stakeholders objecting to parking losses. This can lead to sub-optimal design changes that introduce safety risks. This is a common issue, and regardless of how much information is provided to the decision makers, the design can be overridden by external influences. A range of measures will likely be needed to address this issue. However, the Safe System Audit is the most commonly used and required measure and has the greatest potential to influence outcomes.

Many of the issues raised in the research generally relate to insufficient space for all modes including parking, this is a function of the existing standard carriageway and corridor widths in New Zealand and many other jurisdictions. Addressing this involves design standards for new roads with consideration of what needs to be catered for on the range of street types with their unique contexts and modal priorities.

An example of the strategies as they apply to one of the key safety risks associated with on-street parking is included below.

6.2 Dooring

A car door opening into a cyclist's path was clearly noted in the literature review and safety analysis as a key risk for cyclists in relation to parking. Mitigating this risk requires a safe system approach as outlined below where a range of measures could be applied.

Safe roads - Measures include:

- Remove parking – this will be a key decision in the street space allocation design process
- Provide separated cycle paths
- Cycle lanes located next to on-street parking should be at least 1.8m wide
- Buffer marking on cycle lanes to encourage riding away from doors
- Sharrow markings in shared traffic lanes (low volume, low speed roads) also help cyclists locate themselves away from car doors

Safe speeds – Measures include:

- Apply the safe and appropriate speed

Safe vehicles– Measures include:

- Ride share notification apps - It is noted that Uber has added messaging to customer apps when customers are being dropped off in a street with on-road cycle lanes to check for cyclists before exiting the vehicle.
- Proximity detection – It is noted that both Ford and Volkswagen are taking steps to prevent occupants in their vehicles from "dooring" cyclists and other vulnerable road users. Both companies will be implementing warning systems in more and more of their vehicles.

Safe users – Measures include

- Dutch Reach method – This is where people use their left hand to open the door, forcing them to look over their shoulder, this is mentioned in the NZ Road Code but not promoted.
- Cycle riding location training /education regarding where to ride in the cycle lane or in a traffic lane next to parking without cycle lanes.

7 Case studies

Case studies for a range of street projects and street types were developed to examine real life situations where road space allocation decisions involved on-street parking and how the design changed because of these. Any negative impacts are discussed with recommendations on how any appropriate strategies developed in the research could assist. The focus of the case studies was generally higher traffic volume roads with parking where safety risks are therefore potentially higher. The case studies are listed below:

- St Asaph Street Cycleway Christchurch - Street with a separated cycleway where a business group opposed first design due to parking loss

- SH 1 One-way pair cycleway (Castle and Cumberland Streets – southbound and Great King Street – northbound) - High traffic volume street with separated cycleway where a business group opposed first design due to parking loss
- Queen Street Upgrade, Richmond - Kerbless shopping street with parallel parking with flush separator, achieves low speed environment but some initial usage issues
- Franklin Road Upgrade, Auckland - Wide indented bays with confusion over how to use them and potential accessibility issues to and from the spaces
- Carrington Road, Auckland - High traffic volume street with width constraints and some parking still remaining
- Mt Roskill Safer Communities Programme (various street types) - Street changes near a school to improve safety of children and the general community

The case studies identified a number of themes as discussed below.

7.1 Re-allocating space on existing streets

In several of the case studies, the initial designs removed some on-street parking to accommodate space for cycling. In each case, the businesses or residents on those streets expressed concern about how this would impact their businesses, generally viewing the change as negative. This led to revisions in the design, with car park spaces added back into the design, potentially resulting in suboptimal design outcomes that do not align with vision zero outcome, as seen in the St Asaph Street case study.

The retention of parking on the south side of St Asaph Street created visibility issues for drivers turning left into driveways, as they were unable to see cyclists on the inside of the parking. Although the CNG guidance was followed, concerns from road users persist, and additional mitigations have been added to the design over time. This indicates that a review of the setback requirements is warranted. Such a review could involve assessing a range of cycleways implemented since the guidance was developed, to ensure they are fit for purpose and aligned with Safe System principles for the protection of vulnerable road users. The Dunedin SH1 case study was similar to St Asaph Street in terms of design but does not appear to have had the same challenges with driveway visibility.

7.2 Road user behaviour

Two of the case studies found that unexpected driver behaviour resulted from designs unfamiliar to the public. Some of the behaviours could be addressed through design changes, while others required road user education.

In the case of Queen Street, the kerbless street initially experienced issues with people parking over the footpath and undertaking U-turns that encroached onto it. This required an education campaign, and the issues now appear to have settled. Some parking over the flush gardens was causing damage, this was addressed using simple design changes.

In the case of Franklin Road, the wide unmarked, indented car park bays between the trees have been used as angle parking. This resulted in vehicles encroaching into the cycle lane, prompting the need for road user education.

7.3 Safety and design mitigations

In several of the case studies, some of the mitigations developed were identified as ways to improve safety outcomes.

In the case of Queen Street, the use of sharrow markings would help communicate to both cyclists and to drivers that cyclists need to ride away from the parked car doors, thereby reducing the risk of dooring crashes. Notably, one serious bicycle crash has occurred since the street upgrade was completed.

In the case of Franklin Road, the wide bays could be marked as parallel parking spaces to help communicate to drivers that they should not park on an angle. This would reduce the

risk of vehicles overhanging into the cycle lanes and creating a pinch point that may force cyclists into the traffic lane.

8 Discussion

As well as the safety issues associated with on-street parking, there are other parking-related impacts that can hinder achieving good multi-modal outcomes. Illegal parking behaviour can create issues for people using cycle facilities and footpaths, particularly people with mobility impairments). It was also found that cyclists feel less safe riding in places where there are parked cars, even if a cycle lane is present. This can contribute to people choosing not to cycle.

Good parking policy and management can support improved safety and multi-modal outcomes. Parking management can also guide the location of on-street parking through a parking space hierarchy that prioritises the types of parking in different areas or street types. This approach can help allocate road space for other uses, such as cycle facilities.

There are various ways parking can be provided within a street, each with advantages and disadvantages depending on the context. When designing streets, practitioners must consider a range of parking-related aspects as part of the parking layout decision, including any local parking management plan, the role of the street, speed management, traffic characteristics, space available and external factors. Good street design can reduce the likelihood of a crash. The Safe System Audit process should identify any parking related safety issues and can be used by RCAs to engage with stakeholders advocating for designs that may result in suboptimal safety outcomes.

Safety and design mitigation strategies play an integral role in shaping parking layout decisions, particularly in efforts to enhance road safety and support multi-modal transport outcomes. The research identified a range of existing and potential strategies. Cyclist safety emerged as the area with the greatest number of mitigation options, reflecting the heightened risks associated with different layout configurations involving cycle infrastructure and parking.

9 Limitations and future research

While the results from this research seem relatively sound, as with any study, there are inherent limitations in the breadth and depth of analysis that can be achieved within available time and resources. In this research, several factors may have influenced the interpretation and generalisability of its findings.

Firstly, the analysis relied heavily on Crash Analysis System (CAS) data, which does not consistently code crashes indirectly related to parking (e.g., visibility obstruction near intersections or driveways), potentially under-representing the true extent of parking related safety risks. Secondly, Accident Compensation Corporation (ACC) data could not distinguish between on-street and off-street parking incidents, limiting its utility for comparative analysis. The study did not incorporate exposure metrics such as traffic volume or modal share, nor did it control for confounding factors like road user behaviour, speed environment, or land use. These aspects, along with causal mechanisms and comparative risk analysis, are recommended areas for future research.

10 Recommendations

Despite the limitations and opportunities for further research, a range of recommendations have emerged that could help address parking-related safety issues and contribute to better multi-modal outcomes.

Regulatory:

- A legislative approach may be required to ensure what is ultimately approved for implementation has been subject to a Safe System Audit, in order to reduce the risk of constructing designs that are likely to result in adverse safety outcomes.
- Fine levels for parking infringements that negatively impact safety should be increased to influence people's decisions about how and where to park, thereby reducing the risks associated with parking violations for other users.
- A review of legal requirements should be undertaken regarding the minimum distance at which parking is prohibited near intersections, driveways, and pedestrian crossings, to improve visibility and safety.
- District Plans and Codes of Practice should require new roads to align with the ONF modal outcomes and consider the need for sufficient space for all modes, including parking where it is to be provided. This is essential for achieving good design outcomes.

Behaviour

- The left hand (Dutch Reach) method, already included in the NZ Road Code should be promoted through publicity campaigns, added to the Defensive Driving course and incorporated into the driver licensing process (e.g. the multi-choice quiz).
- Cycle skills training should include (if not already) the awareness of car door opening and lateral positioning when riding in cycle lanes and shared traffic lanes.

Safety campaigns

- Transportation practitioners and street designers (including landscape architects and urban designers) should be informed of the findings and the design recommendations from this research, as these are likely to take time to be included into legal requirements or guidance documents.

Design guidance

- The NZTA ONF Detailed Design Guide (NZTA, 2023), the Aotearoa Urban Street Planning and Design Guide (NZTA,2022) and the Speed Management Guide (NZTA, 2022a), should reflect the findings of this research with respect to parking design and safety outcomes when next updated.
- NZTA Traffic Control Devices Manual Part 13 (Parking Controls) (NZTA, 2007) should be updated with consideration of the matters raised in the research.
- The NZTA Cycle Network Guidance and Pedestrian Network Guidance should be updated to reflect specific safety issues and mitigation strategies identified in the study.

Crash data collection

- Crash Analysis System data fields should record the type of car (e.g., sedan vs SUV), as the vehicle type may influence the crash cause.
- Accident Compensation Corporation claims data should clearly differentiate between on-street and off-street parking related accidents. Currently, no such distinction exists, making it difficult to use the data in context.

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12 References

Auckland Transport. (n.d.). Transport design manual, engineering design code – Parking design, version 1

Bowie, C., Thomas, J., Davison, A., O'Donnell, K., & Kortegast, P. (2019). Factors affecting cycling levels of service (NZ Transport Agency research report 660).

Biswas, S., Chandra, S. & Ghosh, I. (2017). Effects of on-street parking in urban context: A critical review. Transportation in Developing Economies, 3, DOI 10.1007/s40890-017-0040-2.

Injury Prevention Research Unit (IPRU). (n.d.). NZ Cyclist Dooring map released by IPRU. University of Otago. https://blogs.otago.ac.nz/ipru/research/cyclistdooringmap/

Lindenmann, H. (2007). The Design of Roads and of the Road Environment in Small Rural Communities. Transportation Research Record, 2025(1), 53-62.

Mackie, H., Hawley, G., Scott, R., & Woodward, A. (2017). Towards a safe system for cycling: Development and application of a cycling safety system model preparing New Zealanders for utility cycling (NZ Transport Agency research report 606). https://www.nzta.govt.nz/resources/research/reports/606/

Marshall, W., Garrick, N., & Hansen, G. (2008). Reassessing On-Street Parking. Transportation Research Record, 2046(1), 45-52.

NZ Transport Agency (2022), Aotearoa urban street planning and design guide

https://nzta.govt.nz/resources/aotearoa-urban-street-planning-and-design-guide/

NZ Transport Agency (2021a). National Parking Management Guidance https://www.nzta.govt.nz/roads-and-rail/national-parking-management-guidance/

NZ Transport Agency (2023). One Network Framework https://www.nzta.govt.nz/planning-and-investment/planning/one-network-framework/

NZ Transport Agency (2007). Traffic Control Devices Manual Part 13 – Parking Control. https://www.nzta.govt.nz/assets/resources/traffic-control-devices-manual/part-13-parking-control/docs/13-parking-control.pdf

NZ Transport Agency (2022a). Speed Management Guide, Road to Zero edition. https://www.nzta.govt.nz/assets/resources/speed-management-guide-road-to-zero-edition/speed-management-guide-road-to-zero-edition.pdf

Praburam, G. & Koorey, G. (2015). Effect of on-street parking on traffic speeds. Paper presented at IPENZ Transportation Group Conference, Christchurch, New Zealand.

Schimek, P. (2018). Bike lanes next to on-street parking. Accident Analysis & Prevention, 120, 74-82.

Sisiopiku, V. (2001). On-street parking on state roads. ITE Annual Meeting Compendium, Washington DC

ViaStrada Ltd (2021). Safety of people travelling outside vehicles. Deep dive review: First and second phase. Report for Auckland Transport, Nov 2021.

Ward, J., Turner, S,. Fayaz Mansoor, A. (2024). The road safety and multi-modal impacts of on-street parking, NZ Transport Agency RR711.