QUT

DNB311 INDUSTRIAL DESIGN CAPSTONE

RESEARCH REPORT

A Shared Responsibility: Reducing Truck Blind Spot Risk for Vulnerable Road Users

ALICE BARKER

2026



ACKNOWLEDGEMENTS

AUTHENTICITY STATEMENT

This is to certify that to the best of my knowledge; the content of this report is my own work. This report has not been submitted for any subject or for other purposes. I certify that the intellectual content of this report is the product of my own work and that all the assistance received in preparing this report and sources have been acknowledged.

Name: Alice Barker
Date: 13/09/2026

AI USE STATEMENT

I have utilised AI in this report (Claude) to assist in various ways. The way I have used AI has been to reduce word count, transcribing interview audio, coding qualitative responses in interviews and to review the implications section, suggesting transition sentences between paragraphs.

Name: Alice Barker
Date: 13/09/2026

ACKNOWLEDGMENT OF COUNTRY

The Queensland University of Technology (QUT) and I acknowledges the Turrbal and Yugara people, as the First Nations owners of the lands where QUT now stands. We pay respects to their Elders, lores, customs and creation spirits. We recognise that these lands have always been places of teaching, research and learning and that sovereignty was never seeded. QUT acknowledges the important role Aboriginal and Torres Strait Islander people play within the QUT community.

Word Count: 4168

EXECUTIVE SUMMARY

This report investigates how vulnerable road users (VRUs) interact within truck blind spots and how truck drivers currently experience and manage these risks in Australia. The freight and logistics industry underpins a significant share of Australia's economy, yet blind spots around trucks continue to expose VRUs to disproportionately severe and often fatal collisions.

This mixed-methods study identified gaps in truck driver and VRU knowledge of blind spot safety around trucks. The findings support the need for solutions for the truck drivers and VRUs to share responsibility and imrpove safety in blind spots around trucks.

The research identified specific gaps in blind spot awareness, existing detection technology, and regulation that leave both drivers and VRUs without adequate protection, particularly across small operator fleets that makes up the majority of trucks on Australian roads. By examining current sensing technologies - including radar, camera, thermal and multi-sensor fusion systems - alongside the regulatory and commercial landscape, the report identifies where existing solutions fail to reach the Australian market.

The report combines findings from secondary research, product and technology benchmarking, and primary research with truck drivers, VRUs and an industry expert, to identify key opportunities for an intervention that aligns with the needs for the majority of the Australian market.

The findings suggest shifting blind spot safety from a driver-only responsibility to a shared-responsibility model, with key opportunities lying in closing the detection gap, communicating risk directly to VRUs, and delivering a solution that is affordable, retrofit-compatible, and suited to Australian operating conditions.

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SECTION 1

INTRODUCTION

1.1 Introduction
1.2 Project Structure
1.3 Background
1.4 Benchmarking

1.1 INTRODUCTION

OVERVIEW

The freight and logistics industry makes up 8.6% of Australia's GDP (Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, 2022). That's nearly 1/12th of Australia's entire economic output, relying on trucks and drivers to move freight around the country. Trucks are a workplace and should be treated with the same levels of safety and protection as any other job. The industry won't disappear in the next few decades, so it is essential to provide the necessary support to the drivers to complete their work on time and safely.

Blind spots around trucks put VRUs at risk of collisions that are often fatal and typically come without warning but the VRUs need to be aware of the blind spots and share the responsibility of road safety.

The aim of this project is to understand how truck drivers and VRUs experience and manage blind spot safety around trucks, and to use that understanding to develop a realistic, manufacturable and commercially viable product that reduces this risk for the smaller operators who make up the majority of the Australian fleet

1.2 PROJECT STRUCTURE

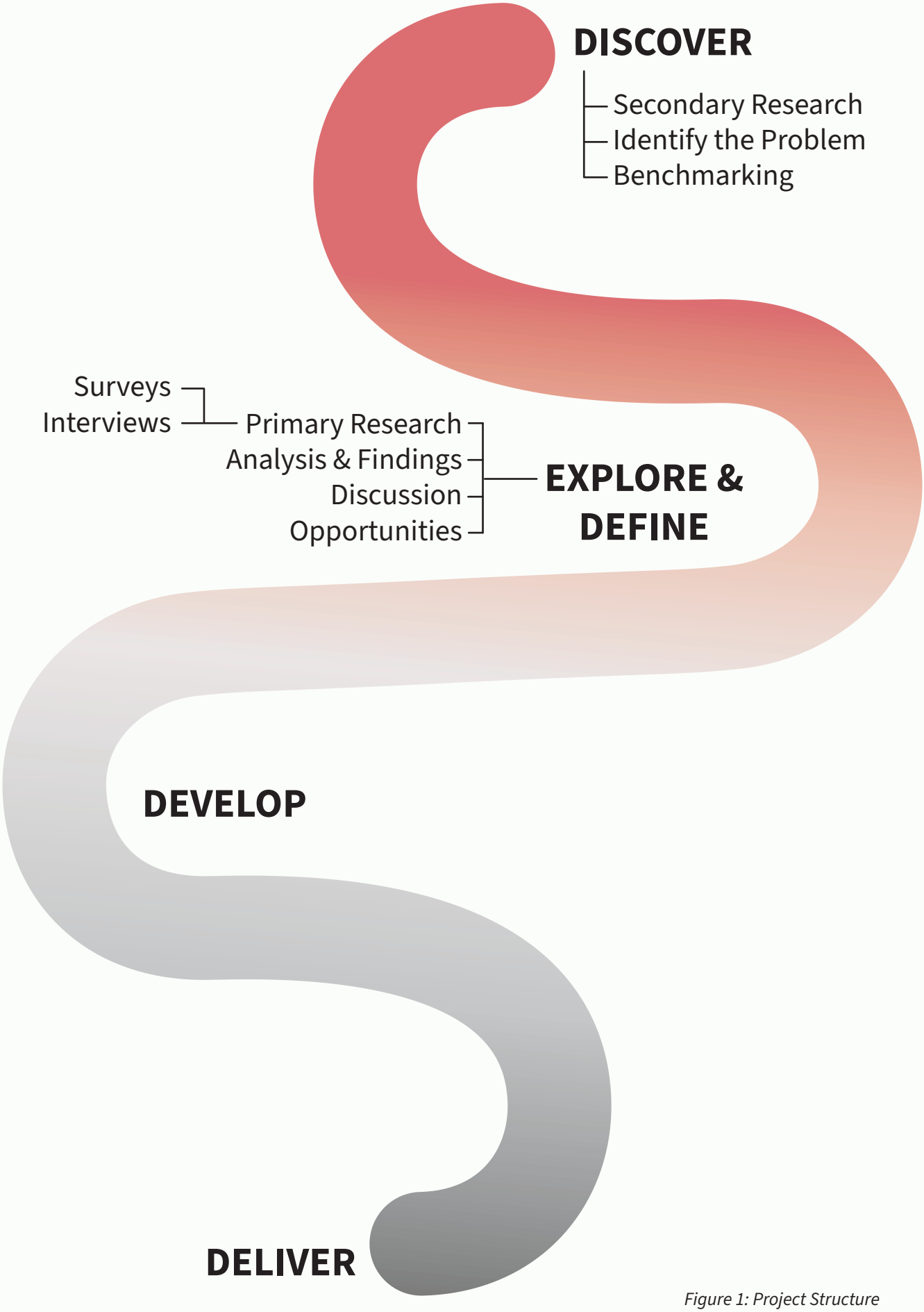


Figure 1: Project Structure

1.3 BACKGROUND

BLIND SPOTS

Blind spots exist around all vehicles, but they are particularly noticeable around trucks because of their large body size, elevated driver's cabin position, and limited visibility from the rear-view mirrors (Dong, 2025). VRUs in a truck's blind spot are exposed to a higher chance of fatal accidents, typically without warning. Indirect vision is also demanding to use, as a driver must check six mirrors and three windows to know whether a cyclist or pedestrian is beside the vehicle (Loughborough University, 2019).

The physical limitations of the truck are only part of the problem. Transurban Limited (2026) surveyed Melbourne, Sydney and Brisbane drivers, and only 4% could correctly identify all truck blind spots. 81% could identify at least one but only 20–24% were aware of the front blind spot. A campaign by Girteka (2025) made the same point to its participants and to the public (Figure 2).



Figure 2: What Cab-over Truck Drivers see vs What's Actually Around (Images sourced from Girteka (2025)

SCALE

Neither BITRE nor the Road Safety Data Hub reports how many VRU accidents occur because of truck blind spots, so the extent of the problem has to be inferred. Road deaths involving heavy vehicles rose 22.3% in the 12 months to March 2026, with deaths involving heavy rigid trucks up 24.7% and articulated trucks up 26.9% (BITRE, 2026). BITRE (2025b) also reports significant increases in road deaths over the last four years for motorcyclists (+49%) and pedestrians (+21%), with pedestrians accounting for 7% of hospitalised injuries but 14% of deaths. A growing truck fleet and population increase the chance of collisions with VRUs, and a truck's weight and impact force make those collisions more severe for both parties.

REGULATIONS

Australia's blind spot standard was written for European winters but most of Australia isn't having one. The ADR 105/00 adopted UN R151 (UNECE, 2023), which specifies sensor contamination as ice, snow, mud and dirt. These hazards do occur in Australia, but the dominant fouling and blinding modes, dust and low-angle solar glare on side-facing sensors, are not named (Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, 2023).

The standard is also narrower than it looks. Bicycle-only detection operates between 0–30km/hour and only above 15 lux, and BSIS becomes mandatory from 1 February 2027 only for goods vehicles over 8t GVM and wider than 2,500mm, so a conventional Australian truck may fall outside the requirement. It also applies to new vehicles, not to the trucks already on the road.

Larger companies write VRU protection into contracts per CLOCS-A to satisfy Chain of Responsibility primary duties under the HVNL, but there is no equivalent for smaller operators and owner-drivers, whose limited resources make navigating complex and inconsistent access regulations more difficult (NHRVSI, 2025).

THE MARKET

Waiting for the fleet to naturally renew is not a realistic answer. Approximately 77.5% of the Australian fleet was manufactured before 2020 and the average heavy rigid truck is 16.1 years old (BITRE, 2025a). Austroads (2021) found few forces driving fleet renewal in Australia, no secondary disposal market for used trucks, and a depreciation structure that makes replacement hard to justify for a small operator. A standard applying only to new vehicles can take up to 35 years to reach the whole fleet, meaning Australian roads will still be as dangerous for the next two decades.

Age alone is not the issue. Austroads (2021) also found trucks over 15 years old crash no more often than trucks aged 5 to 15 years, and that vehicle age is not a major causal factor in most heavy vehicle crashes. What matters more for VRUs is where these trucks work and who is at fault. Rigid trucks travel 65–75% of their kilometres in urban areas, and up to 83% of multi-vehicle fatal crashes involving a heavy vehicle are caused by a third party rather than the truck or its driver (NTARC, as cited in Austroads, 2021). 93% of operators haul less than 5 units and hold 54% of the national fleet, whilst the 20 largest companies hold only 2.4% (NHVR, 2025). A solution therefore has to be viable for these smaller operators, the majority of the market.

1.4 BENCHMARKING

OVERVIEW

Benchmarking establishes what the market currently offers and what remains unaddressed. Nine existing products and ten sensing technologies were assessed to identify where current solutions fail, and where a design opportunity exists.

PRODUCT MATRIX

Nine products were assessed against a defined rubric (Appendix A). Mirrors, DNOTV signs, Spotto, SGESCO-MAX and Mobileye Shield+ were selected based on performance and regulatory status. Six of the nine products benchmarked published no environmental specification, and where a claim is made, it is not proven. SGESCO-MAX (2026c) advertises “superior performance in all weather conditions” while its Head of Research & Development acknowledges that cameras degrade in sunlight, darkness and heavy rain (McPherson, 2024). The criteria scores are weighted (Table 1). As established in the Market Scale, the fleet is dominated by small operators running fewer than five hauling units, so accessibility is weighted most heavily (22%). A solution that cannot be bought and fitted by an operator with fewer than five vehicles is not addressing the majority of the fleet. VRU communication, detection and Australian operating conditions follow.

Table 1: Existing Product Matrix (Refer to Appendix A for complete analysis and criteria information)

PRODUCT	DNOTV SIGN	MIRRORS	SPOTTO	SGESCO-MAX	MOBILEYE SHIELD+
Detection	1	1	3	4	5
VRU Communication	2	1	1	4	2
Accessibility	5	4	4	1	2
AU Operating Conditions	3	2	4	3	2
Driver Load	5	4	4	4	4
False alarm rate	2	5	3	3	5
Physical integration	5	3	3	4	4
Raw Score	23	20	22	23	**24**
Weighted Score	**21.7**	18.3	21.2	21.6	21.6

SCORE SCALE: 1 — Poor | 2 | 3 — Moderate | 4 | 5 — Excellent

The DNOTV sign lacks detection and active VRU communication however it ranks first because it is easily integrated, adds no driver load, and is very accessible.

Mobileye Shield+ has the highest detection, but also the worst in Australian operating conditions because it uses cameras (Figure 3).

SGESCO-MAX is arguably the “best” product on the market, but its pathway to purchase – dealer-only installation, price on application, bespoke per-body engineering and a two-year capex approval at Foodstuffs – makes it the hardest to access, effectively excluding small operators (SGESCO-MAX, 2023).

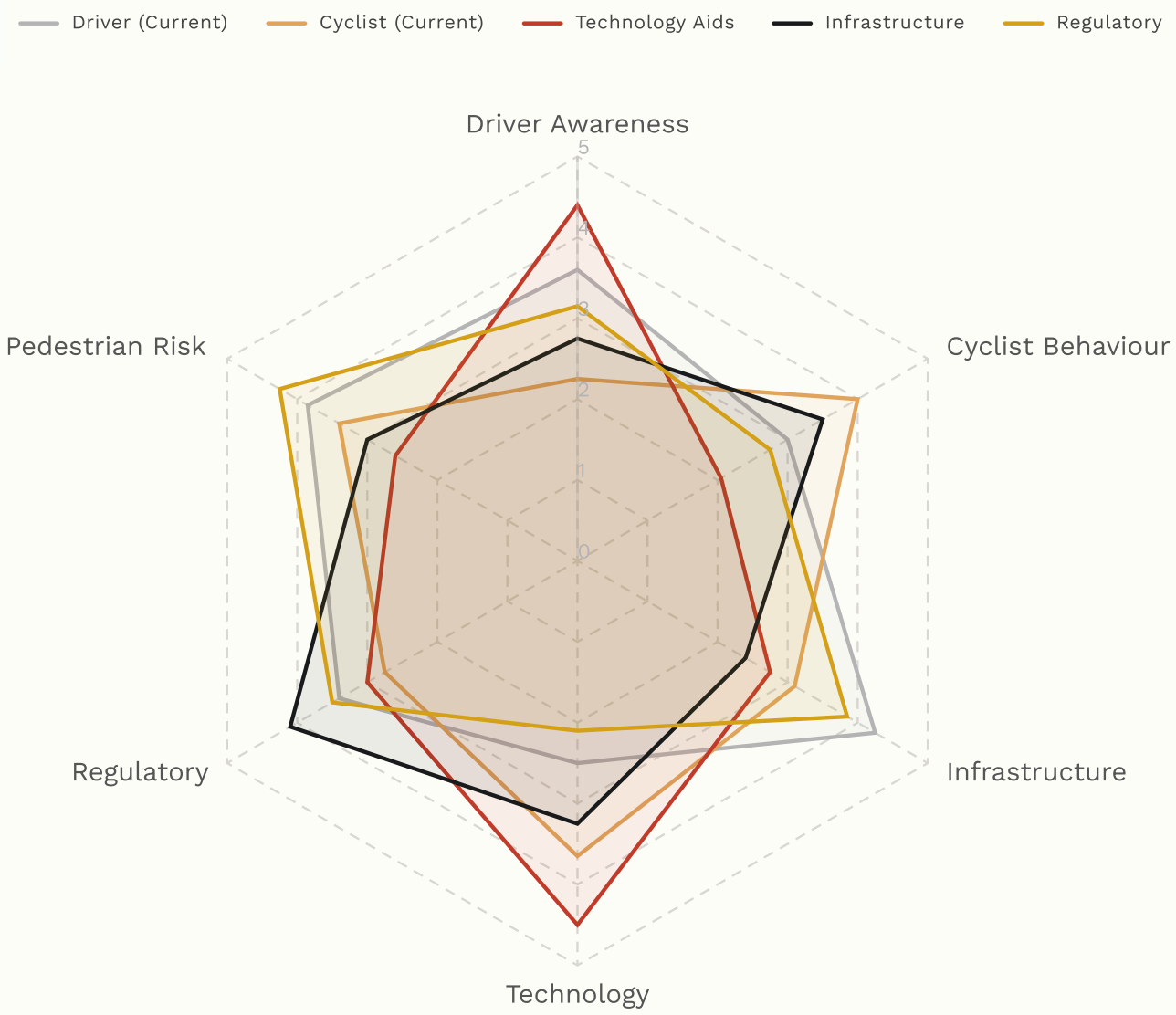


Figure 3: Spider Chart Comparing the Existing Market Products & Solutions

REGULATIONS

Mirrors are mandatory under ADR 14/03, and the DNOTV sign under state road rules is mandatory for vehicles 7.5m or longer. Every other product benchmarked is voluntary, and their adoption reflects this. The most capable systems are found in large fleets that acquire them via CLOCS-A procurement or Chain of Responsibility requirements, but these do not extend to small operators, indicating regulations determine what appears on an Australian truck.

TECHNOLOGY MATRIX

Product benchmarking cannot show whether a limitation is inherent or chosen. Assessing the underlying technologies separates physical constraint from commercial choice.

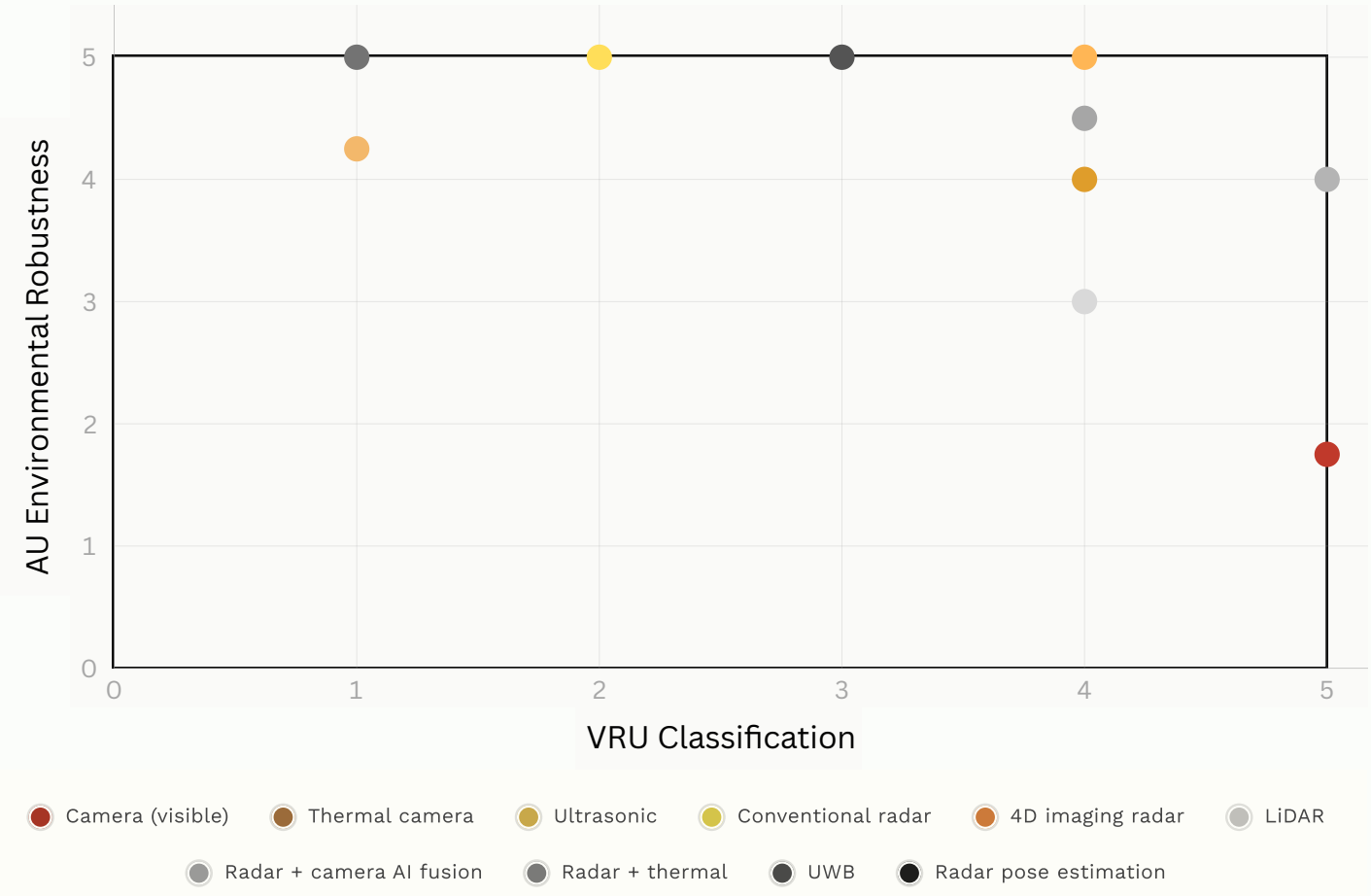


Figure 4: Technology Matrix

Low-angle glare tolerance is the most discriminating criterion in the matrix. The camera scores 1 because it depends on visible light; radar and thermal score 5. A side-facing camera takes direct sun at dawn and dusk, during peak commuting hours, so a solution for Australian conditions must address both dust and glare.

UWB scores well almost everywhere but is impractical for public roads, as it requires the VRU to carry a tag which cannot be mandated in public spaces.

4D imaging radar, radar + thermal, and radar + camera AI fusion, all sit high on both axes, indicating that multi-sensor systems outperform single-sensor ones. Only one of the nine products uses any of them, and it is the least accessible.

OPPORTUNITIES

SGESCO-MAX proves outward communication works and can be built today but reaches only large fleets. The accessible products – Spotto, mirrors, the DNOTV sign – deliver nothing outward at all. Meanwhile the standard everyone designs to was written for European conditions, so compliant systems can fail silently in Australian sun, dust and darkness, leaving operators believing they are protected when they are not.

With BSIS becoming mandatory from 2027, technology capability suited to Australian conditions already exists commercially but is not being selected. The opportunity is a solution accessible to small operators, that increases vulnerable road user understanding, and is specified for Australian dust, glare and darkness.

SUMMARY

Benchmarking shows a market where capability and accessibility run inverse. The most capable systems reach only large fleets, the accessible ones communicate nothing to the road user at risk, and no product is specified for Australian conditions. The gap is commercial rather than technological.

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SECTION 2

RESEARCH

2.1 Primary Research
2.2 Analysis & Findings

2.1 PRIMARY RESEARCH

OVERVIEW

Following secondary research to identify gaps in the management of blind spot safety around trucks primary research was undertaken to validate findings with truck drivers and VRUs and explore further the need for additional systems to improve safety in blind spots around trucks. This section outlines the research methodology, the approach and rationale for the methods chosen, data collection and analysis to ensure transparency and validity of the approach.

The hypothesis was blind spots still exist around trucks, increasing the likelihood that VRUs may be difficult for truck drivers to detect. Using a deductive research method the goal was to test the theory that VRU detection in blind spots do still exist around trucks.

METHODOLOGY

Primary research used mixed methodology combining qualitative and quantitative methods within the study to develop a more comprehensive understanding of a complex issue. The main objective of using mixed methods was to use the strengths of both approach methods while compensating for respective weaknesses. By integrating the depth of qualitative data with the reliability and generalisability of quantitative data, mixed-methods research provides a more comprehensive and detailed understanding of research questions (Saraswati P, et al, 2023) .

Using a mixed-methods approach enables the triangulation of data by combining qualitative and quantitative findings, providing a more comprehensive and reliable understanding of the research topic. Triangulation increases validation of data through cross verification from two or more sources. It refers to the application and combination of research methods in the study of the same phenomenon.

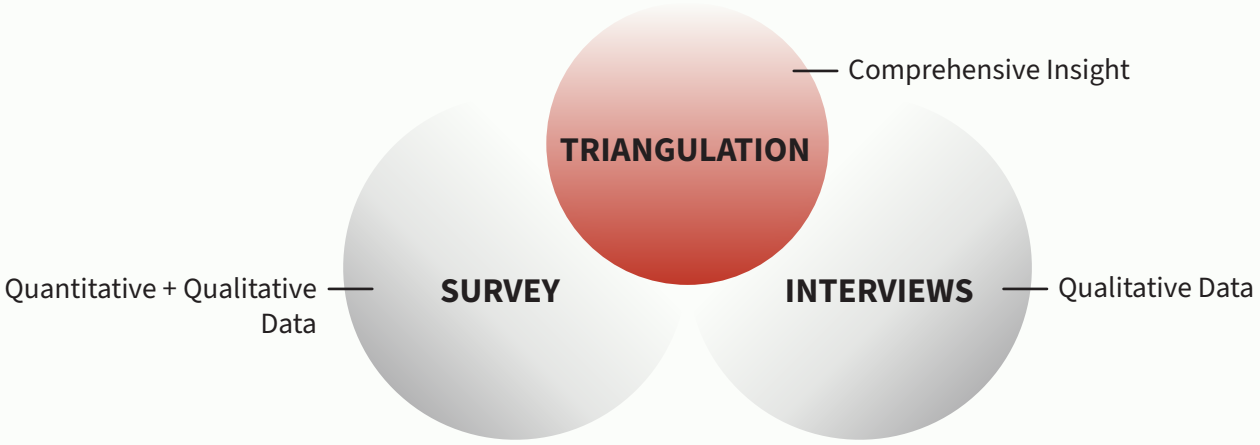


Figure 5: Methods Implemented to Triangulate Data

PARTICIPANT RECRUITMENT

Participants were randomly selected through networks of truck drivers, industry experts and VRUs. In total 48 survey participants were identified and 5 interviewees. A Participant Information Sheet was provided (Appendix C) and all participants completed a consent form (Appendix D).

QUANTITATIVE METHODS

An online survey was designed in Qualtrics platform allowing for collection of both quantitative and qualitative data, organisation and analysis on findings. Online survey was chosen as it provided a cost-effective and efficient method of collecting standardised data from a large and geographically diverse sample, while allowing participants to respond conveniently and anonymously. Responses were mainly using a 5-point Likert scale, a psychometric rating system to measure attitudes, opinions, and perceptions by asking people to rate their level of agreement with a statement (Sullivan & Artino, 2013). Responses were ranked as disagree, somewhat agree, neutral, somewhat agree and agree and responses aggregated. (Appendix E). The end of each section included an open-ended question for further comments and the option to provide contact details if they agreed to be approached for interview.

QUALITATIVE METHODS

Semi-structured interview method allowed collection of comparable data from predetermined questions alongside adaptive probing for further in-depth insights. The interview questions were provided to participants the day prior to the interview. (Appendix G) Responses were recorded, transcribed verbatim and key themes and insights provided using Otter.ai.

ETHICS APPROVAL

QUT Ethics Approval Number #11424 was provided by QUT.

PARTICIPANT ENGAGEMENT

Overall response rate was 59% (31/53 participants) (Table 2). Survey response rate was 54%, 26 of 48 participants, with 5 incomplete results excluded as they couldn't provide clear information. Telephone interview response rate was 100% (5/5) and took between 30-50 minutes.

Table 2: Primary Research Methods and Participant Backgrounds

METHOD	RECRUITMENT METHOD	PARTICIPANTS	BACKGROUND
Survey	Existing connections, friend-of-a-friend, emailed, and texted	26 participants	Truck drivers
			VRU (Cyclist, pedestrians, and motorcyclist)
			Heavy Goods Vehicle Industry related people
Interviews	Follwed up from survey	5 participants	P1 | Cyclist (former truck driver)
			P2 | Former Truck Driver (12+ years experience)
	Emailed/Texted from prior connection		P3 | Truck Driver (with over 15 years experience)
			P4 | HVIA Industry Representative
			P5 | Industry Expert at HVIA

2.2 ANALYSIS & FINDINGS

OVERVIEW

Data was analysed through statistical analysis and thematic coding. Statistical analysis helped identify patterns, trends, and relationships within the numerical data, while thematic coding helped identify key themes and common ideas within the qualitative data. Using both methods provided a more comprehensive understanding of the findings and strengthened the reliability and credibility of the research conclusions.

There were in total 26 responses (Table 3). As there was only one industry expert that participated in the survey, they have been excluded from group comparisons. Their responses are reported qualitatively only.

Table 3: Participant Classification

GROUP	n	%
Truck driver	12	46%
Vulnerable road user (VRU)	13	50%
Industry person	1	4%
Other	0	0%
Total	**26**	**100%**

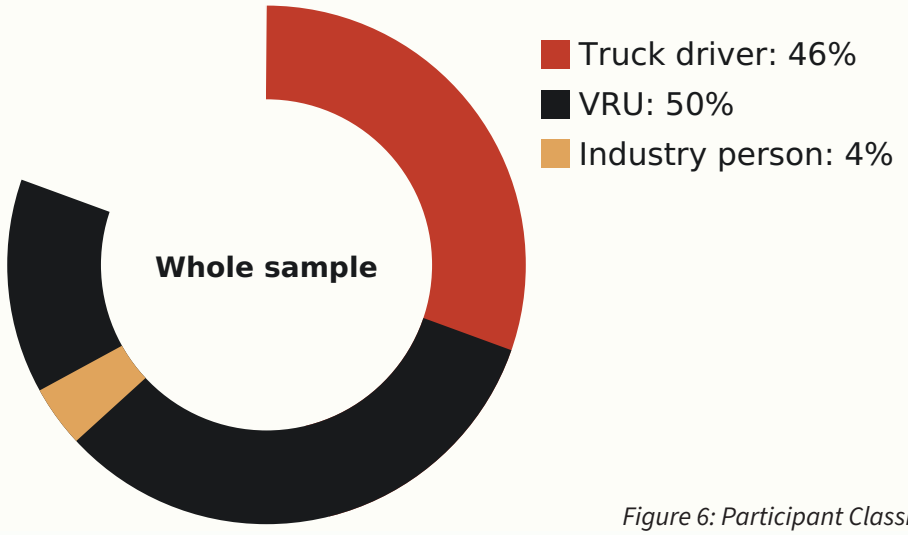


Figure 6: Participant Classification Whole-Sample

STATISTICAL ANALYSIS

PARTICIPANT DEMOGRAPHIC

Statistical analysis includes results from truck drivers and VRUs only. Age range of participants was 18-75 years with over 75% having 10+ years as a truck driver or VRU.

BLIND SPOT IDENTIFICATION KNOWLEDGE

Figure 7 was provided in the survey for participants to identify blind spots around a truck. Areas B, C, F, H, I and K are the blind spots around a truck.

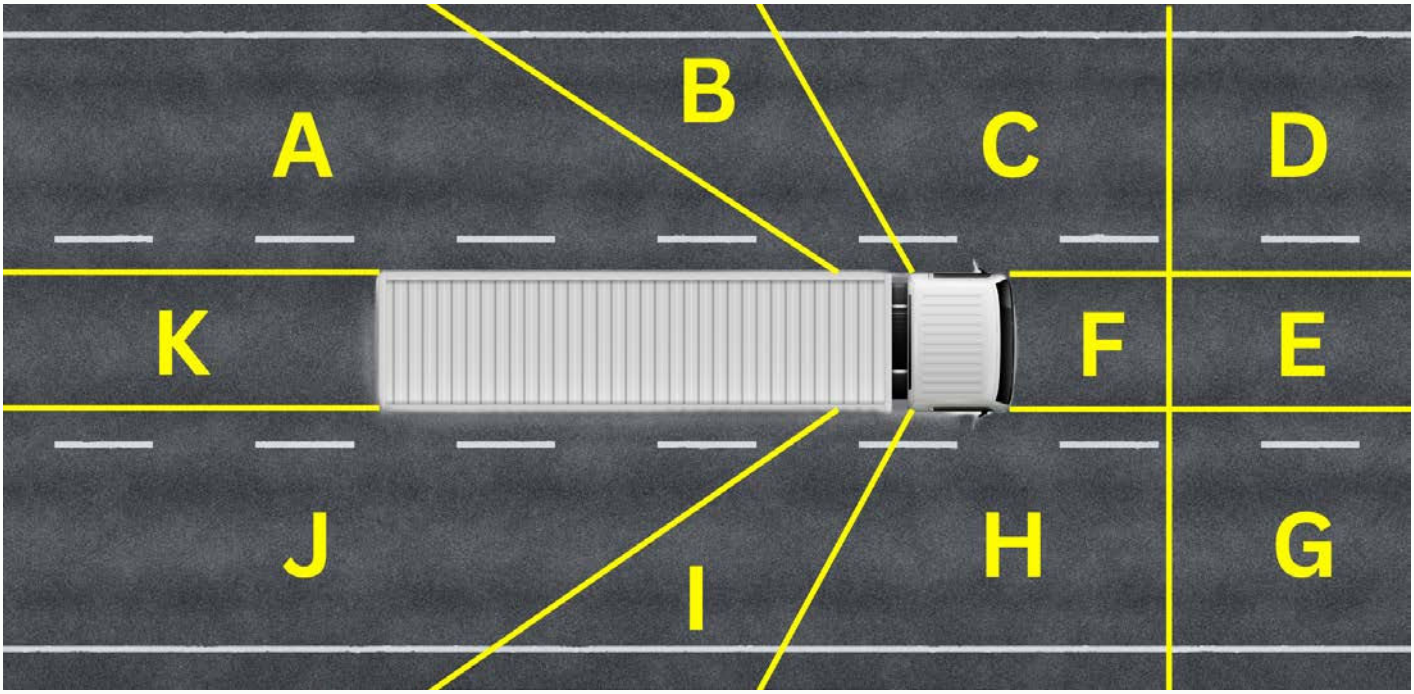


Figure 7: Participant Identification Blind Spot Areas Around a Truck

The shaded areas in Table 4 indicate the correct blind spot areas around a truck. While the truck drivers have a slightly greater understanding of blind spots, not all do. There is a significant lack of knowledge of blind spots by VRUs. For the full table refer to Appendix F, Table F4.

Table 4: Results of Blind Spot Identification by Respondent Group. Highlighted Rows (B, C, F, H, I & K) are the Correct Zones

	TRUCK DRIVERS	VRU
A	20%	69%
B	100%	85%
C	70%	31%
D	0%	15%
E	0%	0%
F	70%	23%
G	10%	15%
H	20%	23%
I	40%	85%
J	10%	69%
K	12%	41%

BLIND SPOT IDENTIFICATION EXPERIENCE

The need for more warnings for VRUs in truck blind spots was agreed to by 87% of participants (Figure 8) while 74% of participants agreed or somewhat agreed new technology could significantly improve safety (Figure 9).

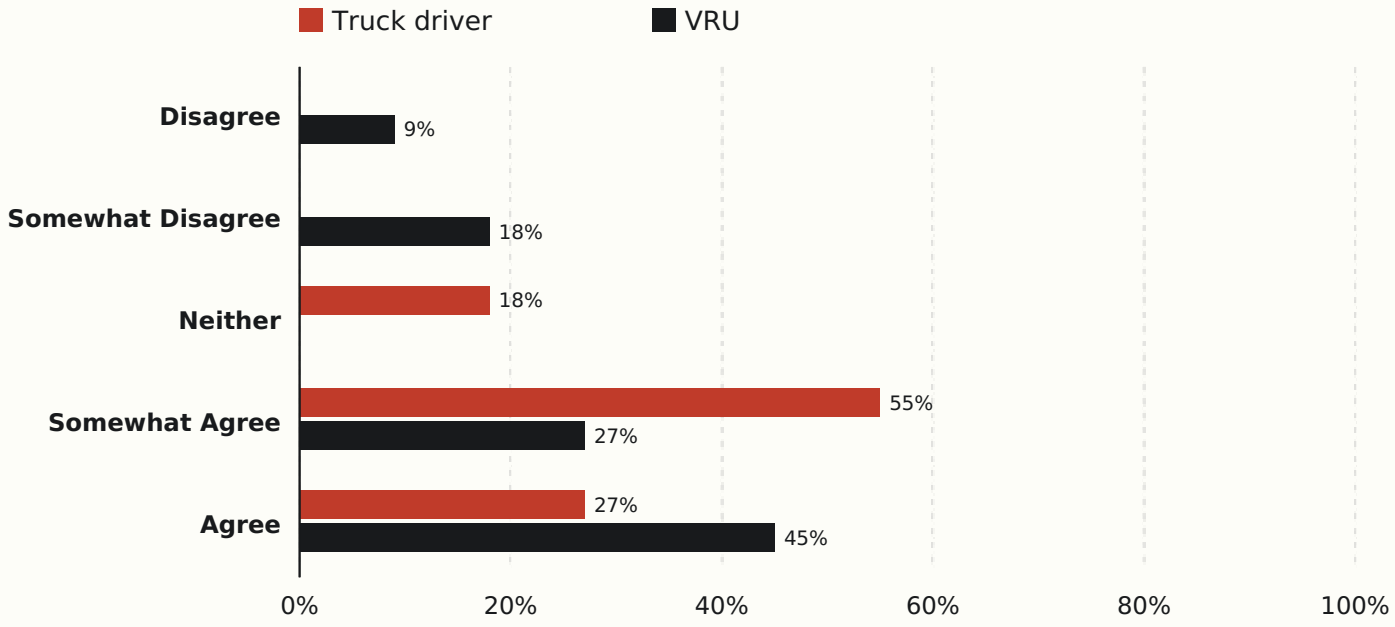


Figure 8: Truck driver vs VRU, % of Each Group's Respondents per Category, Q7e Results - "Needs More Warning For VRUs in Truck Blind Spots"

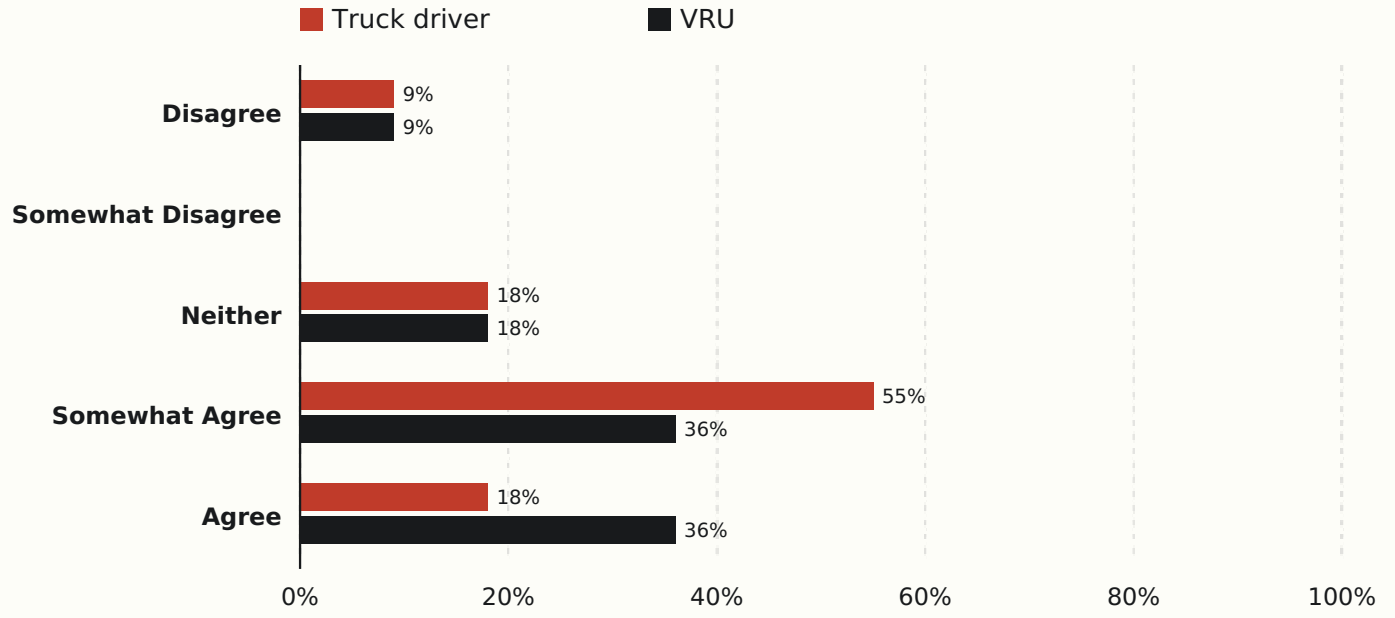


Figure 9: Truck driver vs VRU, % of Each Group's Respondents per Category, Q9b Results - "New Technology Could Significantly Improve Safety"

SUMMARY

Statistical analysis has demonstrated a lack of knowledge of blind spots around trucks and the need for more warning for VRUs to potentially improve safety and avoid harm of VRUs.

THEMATIC ANALYSIS

Thematic analysis used Thematic Analysis Claude Code skill following Braun and Clarke's (2006) six-phase framework. The most common design themes and quotes are reported below.

EMERGING DESIGN THEMES

Table 5 shows the leading themes and the number of times it was mentioned across the 5 interviews (highlights column). For the full thematic analysis coding refer to Appendix H, Table H1.

Table 3: Leading Themes and Count Across All 5 Interviews

LEADING THEME	HIGHLIGHT COUNT	DESCRIPTION
Visibility	76	What the vehicle physically lets the driver see
Driver Capacity	59	How much attention there is to spend
Comprehension	63	Whether a signal's meaning lands
Alert Design	38	How to signal without being ignored or disabled
Road Behaviour	84	What road users actually do
Affordability	26	What the market will pay
Fitment & Reliability	42	Getting it onto the vehicle and keeping it working
Regulation & Evidence	93	What the law requires and what can be proven

VISIBILITY

The majority of responses indicated that while blind spot detection devices are available there are still areas where truck drivers are unable to see people.

> *"The camera sort of points down rather than a wider, more distant view [...] It doesn't actually give me any sense of where I am in relation to another car behind me, or two cyclists who pulled up behind me, or a motorbike." [P1]*

DRIVER CAPACITY

Truck driver overload was mentioned as a barrier for them to further monitor blind spots around the trucks.

> *"If you drive a truck in peak hour traffic [...] you're still physically exhausted and mentally exhausted. Not just physically — mentally exhausted, because your brain is just always looking at everything." [P2]*

COMPREHENSION

Lack of awareness by VRUs was a key theme from the interviews and the need for VRU education to improve this.

> *"The pedestrians would nearly walk over the truck. They have no awareness to be scared of it because they've just got their head in the phone and they're walking forward — they're on a mission." [P3]*

ALERT DESIGN

There are numerous alerts truck drivers already have in trucks which become to distracting and result in being turned off or ignored.

> *"There's lots of things that drivers disable [...] because they find them too nauseating or too interfering." [P1]*

ROAD BEHAVIOUR

It is not always the truck at fault but other road users. The need for information and education for all road users was noted as a key need.

> *"I know of a bloke [truck driver]. […] He was at a set of traffic lights in a truck, on a bit of a hill, and a police car went into his rear blind spot. He [truck driver] didn't see it there… went to take off… rolled back and crushed the police car, the bonnet and everything. [P2]*

AFFORDABILITY

The cost of yet another device and implementation across a wider population was seen as a barrier.

> *"There's a problem with more devices — that's more expensive, and no one can implement them." [P4]*

FITMENT & RELIABILITY

Having a system that is reliable and works is the only way that devices will be taken up.

> *"We've had all these amazing safety systems mandated, and a lot of them aren't functioning [...] a trailer electronic braking system, of which we think 60% of what's fitted is actually not functioning." [P5]*

REGULATION & EVIDENCE

There is need for regulation, compliance and reporting. The lack of data is a significant barrier to implementation of systems to improve safety of truck drivers and VRUs.

> *"This is really easy. Like just force it through registration. No list of safety systems, no vehicle registration. The end." [P5]*

> *"Fifty truck drivers die a year [...] and nobody seems to report or care about that […] and they remove it from the data." [P5]*

THEMATIC ANALYSIS SUMMARY

Themes presented from the research identify the need for devices to identify truck blind spots not just for truck drivers but also other road users. Devices need to avoid more distraction by drivers, available for VRUs and the need for education and training was noted as a key enabler.

SUMMARY

Data analysis and findings from qualitative and quantitative methods from this research identified that there are still gaps in truck driver and VRU knowledge of blind spot safety around trucks. The findings support the need for solutions for the truck drivers and VRUs to share responsibility and imrpove safety in blind spots around trucks.

LIMITATIONS

There were several limitations of the study. First given the range of participants – truck drivers, VRUs, and industry people – the large variety of opinions and experiences resulted in a wide range of data for thematic analysis. Analysis and reporting for this study focused on the major themes presented by the group.

Second, with a survey sample size of one industry participant this resulted in being unable to compare results with the other groups.

Lastly, was the lack of available secondary data. As data is not routinely reported, a clean baseline statistic is unavailable, and inference must be made with the data that has been reported.

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SECTION 3

DISCUSSION & DESIGN IMPLICATIONS

3.1 Discussion
3.2 Design Implications
3.3 Conclusion

3.1 DISCUSSION

Background evidence, consisting of reviewing the literature and benchmarking existing solutions, indicate significant gaps in available systems to improve safety in blind spot detection around trucks. Current systems are only available to large fleets, those that are accessible do not communicate with the vulnerable road users most at risk and there are no products specifically designed for Australian conditions.

Survey and interviews explored knowledge, experience and perspectives of truck drivers, VRUs and industry experts. Statistical analysis demonstrated a significant lack of knowledge of blind spots around trucks and identified the need for more warning systems for VRUs to share responsibility for safety. Thematic analysis reported that despite truck drivers having blind spot detection devices there was still blind spot areas undetected, they were not used routinely and were distracting. VRUs had little knowledge and lack of awareness of blind spots around trucks, did no seem to share responsibility for safety around trucks and there were not specific devices for VRUs to assist in detecting when they may be in a blind spot.

Two significant themes arising from the research. First, regarding regulation and evidence participants highlighted the lack of reliable data, the role of regulation in driving adoption, and the need for demonstrable safety benefits. This is significant because regulation and evidence directly influence whether a safety system is adopted across the Australian trucking industry. Second participants identified that VRU behaviour and lack of awareness contribute significantly to blind-spot risk. This is important because it supports the finding that responsibility for safety cannot sit solely with the truck driver; VRUs also need clear information about when they cannot be seen.

In summary, this study confirms there remains a gap in blind spot detection around trucks by both truck drivers and VRUs and contributes new insights into possible solutions. The evidence provided in the report can be used to frame human-centred design solutions to address this issue.

3.2 DESIGN IMPLICATION

This study's findings show that current blind spot mitigation systems remain overwhelmingly driver-facing, leaving vulnerable road users with no direct means of understanding the risk they're in or protecting themselves within a blind spot. This points to an opportunity to share safety responsibility more evenly between driver and VRU, through design that responds to the real conditions Australian fleets operate in, while limiting the information overload directed at truck drivers.

This shared responsibility depends first on closing the detection gap itself. Driver-reported and survey-identified blind spot zones remain inadequately addressed by current systems – the gap isn't a general lack of safety features, it's specific, named zones drivers still can't see into. This suggests the opportunity lies less in adding another generic sensor and more in designing specifically for the zones drivers have identified as genuinely unresolved.

Closing the detection gap only solves half the problem if the VRU is left out of it. No existing product delivers a risk-triggered outward alert to the VRU – the one partial exception fires on vehicle manoeuvre alone, not on proximity or actual risk, meaning a VRU in a blind spot receives no warning proportional to their actual danger. There is an opportunity here to design a solution that brings the VRU into the safety system directly, rather than relying solely on the driver to notice and respond in time.

Beyond detection and communication, adoption is shaped just as much by whether a solution fits the fleet it's designed for. The Australian truck fleet varies in geometry between cab-over and bonneted trucks, yet existing solutions typically design towards cab-overs, which are quickly disregarded by bonneted truck drivers as the longer bonnet creates larger frontal blind spots. A solution that assumes one geometry excludes a large portion of the Australian fleet, pointing to an opportunity for a design that adapts across truck types rather than favouring one.

Fit alone isn't enough if the solution remains out of reach financially. Small fleet operators make up majority of the Australian fleet, yet no existing solution is scaled or priced with them in mind – current products assume large-fleet purchasing power, pricing out the operators most likely to be running older, less-equipped vehicles. This suggests real opportunity in a design that treats affordability as a core constraint from the outset, not an afterthought once performance has been optimised.

A solution also has to survive the environment it's deployed in. Most current solutions are camera-based, which the research specifically flagged as less reliable in dust, mud and rain – conditions that are routine, not exceptional, for Australian on-road and regional truck operators. This points to an opportunity for a system that may still incorporate a camera, but pairs it with another technology to strengthen durability in these conditions.

Finally, even a well-designed solution can be undermined by how it's installed. No existing solution avoids hardwired installation, which adds cost and ties the unit to a single vehicle – a real barrier for operators managing small fleets or reassigning trailers between jobs. Given that truck drivers already carry out routine walk around checks, there's an opportunity to design a self-powered device, running on solar or battery, that fits naturally into that existing check rather than requiring separate maintenance.

3.3 CONCLUSION

This research report aimed to test the theory that VRU detection in blind spots do still exist around trucks and with truck drivers and VRUs to validate findings and explore further the need for additional systems to improve safety in blind spots around trucks.

The research supports the theory that VRUs can remain undetected when positioned within blind spots around trucks. Both quantitative and qualitative findings identified ongoing gaps in blind spot awareness, visibility and detection, despite existing mirrors and safety technologies. Survey results demonstrated that VRUs had limited knowledge of several truck blind spot areas, while interviews highlighted the physical limitations of vehicle visibility and the additional challenges created by driver fatigue, mental workload and alert overload.

The research also identified that blind spot safety is not solely a truck driver issue. VRU behaviour and limited understanding of when they cannot be seen by a truck driver contribute to the risk. Participants also identified affordability, reliability, fitment and regulatory requirements as important barriers to the adoption of existing technologies, particularly for smaller operators.

Therefore, the findings support the need for an additional safety system that complements existing truck technology rather than placing greater responsibility on the driver. The research indicates an opportunity for an affordable, reliable and retrofit-compatible solution that improves communication of blind spot risk to VRUs while minimising additional driver workload. Such a system could support a shared-responsibility approach to improving safety around trucks.

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APPENDIX A: ABBREVIATIONS & KEY WORDS

Table A1: List of Abbreviations Used Within This Report

ABBREVIATION	FULL TERM	CONTEXT
HGV	Heavy Goods Vehicle	"Truck(s)" has been used to define both trucks and HGV's in this report.
VRU	Vulnerable Road User	Pedestrians, cyclists, motorcyclists
GDP	Gross Domestic Product	
BITRE	Bureau of Infrastructure and Transport Research Economics	Australian Government research body
NHVR	National Heavy Vehicle Regulator	
HVNL	Heavy Vehicle National Law	
CLOCS-A	Construction Logistics and Community Safety – Australia	Contractual VRU safety scheme, adapted from the UK CLOCS scheme
CoR	Chain of Responsibility	Legal duty-holder concept under the HVNL
ADR	Australian Design Rule	Vehicle safety/construction standard. Note: same acronym also means "Alternative Dispute Resolution" in other contexts — worth a footnote on first use
UN R151	United Nations Regulation No. 151	International standard for Blind Spot Information Systems, adopted into ADR 105/00
BSIS	Blind Spot Information System	
GVM	Gross Vehicle Mass	
QUT	Queensland University of Technology	Ethics approval body for this study
NTARC	National Truck Accident Research Centre	Operated by National Transport Insurance (NTI); cited via Austroads
DNOTV	Do Not Overtake Turning Vehicle	The mandatory truck warning sign
UWB	Ultra-Wideband	Radio positioning technology used for tags/proximity detection
LiDAR	Light Detection and Ranging	
IP Rating	Ingress Protection Rating	Standard (IEC 60529) for dust/water resistance of enclosures
ISO	International Organization for Standardization	

APPENDIX B: BENCHMARKING

PRODUCT BENCHMARKING RUBRIC

Table B1: Seven Axes Used to Benchmark Existing Product/Solutions Breakdown and Description

AXIS	WHAT IT MEASURES	1	
Detection	Sensing capability and whether the system can classify a vulnerable road user, as distinct from detecting that something is present.	Reflective surface only; no active detection	Actively target cl metall
VRU communication	Whether the person at risk outside the vehicle learns anything, and how specific and actionable it is.	Nothing outside the cab	Static pe always di stat
Accessibility	Whether an owner-driver can actually obtain and fit this. Combines purchase price, purchase pathway and installation friction.	OEM-fit only, or POA with bespoke per-body engineering and a capex approval process	Dealer r installer; c
AU operating conditions	Whether the system still FUNCTIONS CORRECTLY in Australian conditions - dust, low-angle glare, heat, darkness, heavy rain. Distinct from Durability, which asks whether the hardware survives.	Fails or auto-deactivates in routine Australian conditions with no mitigation	Single- depe degrada rain; no m
Driver load	INVERSE of cognitive load added during the manoeuvre. Includes latency, whether head movement changes the view (motion parallax), focal accommodation demand and training novelty.	Adds a screen the driver must fixate on mid-turn; latency; fixed viewpoint	Adds a active
False alarm rate	INVERSE of nuisance alerting. UN R151 s0.3 treats alert fatigue as a first-order design concern; ADR 105/00 makes it testable by requiring no trigger from parked cars or cones at 4.25 m.	Frequent documented nuisance alerts in normal operation	Known nu the opera guard ra
Physical integration	Protrusion, snag and damage risk, mounting robustness, and whether the device reads as factory-fitted. Renamed from 'Cab integration' so it still applies to side, infrastructure or VRU-mounted concepts.	Bulky multi-part install; visibly bolted on; protrusion or snag risk	Seve componer

2	3	4	5
detects, but wrong lass for VRUs (e.g. lic objects only)	Single-mode sensing, one zone; cannot classify VRU type	Multi-zone or multi-modal; classifies human form	Multi-zone, multi-modal, VRU-classifying, with published trajectory or time-to-collision logic
rmanent signage; splayed, carries no e information	Broadcast alarm tied to a manoeuvre (e.g. fires on indicator)	Detection-triggered, directional alert to the side at risk	Conveys POSITION: the person learns they are in the blind spot and what resolves it
network; certified calibration required	Professional fit, a few hours, no calibration rig	Published price; self-install with hand tools	Under $100, universal, fitted in minutes
mode and light-endent; known tion in sun, dark or itigation published	Some redundancy or partial tolerance; degradation acknowledged but unmitigated	Light-independent sensing (radar), or multi-modal redundancy	Multi-modal redundancy PLUS fouling detection or self-cleaning, specified for dust and glare
display requiring e interpretation	Peripheral display; some interpretation required	Peripheral indicator or audible; near-zero added scan burden	No driver interaction required at all
uisance sources in ting envelope (e.g. ails at low speed)	Plausible rejection but no published data	Classification-based rejection; low nuisance rate claimed	Cannot false-alarm, or published explicit rejection of inanimate objects
eral separate nts; disrupts vehicle lines	Bolt-on but conventional; within regulated protrusion limits	Compact; mounts to existing structure; neat	Flush or integrated; no added protrusion; reads as OEM

COMPLETE PRODUCT BENCHMARKING TABLE

Table B2: Complete Product Benchmarking Table - Information Comparison

ATTRIBUTE	DNOTV SIGN (AS 4001)	MIRRORS (ADR 14 BASELINE)	SPOTTO	BLIND SP
Manufacturer	Various sign makers; specified by VSB 12 / AS 4001-2003	Various (ADR 14 / UNECE R46)	Fleetsafe (AU)	BSS (AU) designed
Technology	Retroreflective sheeting, Class 1 or Class 400. No power, no electronics, no moving parts	Reflective optics; convex Classes II, IV, V, VI	Microwave radar, speed-adaptive	79 GH
Active or passive	Passive - permanently displayed, carries no state information	Passive	Passive (warning only)	Passive (w
Coverage	Rearward only. Readable from 200+ m in line of sight	Rearward + wide-angle + close-proximity + front cross-view	One side per unit. >30 km/h: 3 m x 12 m. <30 km/h: 1.5 m x 3 m	Near-sid
Detects	Nothing. It is a statement, not a sensor	Nothing - the driver must look	Vehicles >30 km/h; pedestrians and cyclists <30 km/h (Turn Assist)	Vehicle pedestria cl
Driver interface	None - this device faces away from the cab	Direct glance. Zero latency, natural depth cues, and the view changes when the driver moves their head - no camera reproduces this	LED indicator + audible when indicator on	Visual
VRU COMMUNICATION	YES - the only permanently outward-facing device here. Static, text-based, rearward, always on	None	None	N
Price (AUD)	~$20-50 (assumed, sign retailers) - the zero-cost baseline	~$150-600 per mirror replacement (assumed)	$990 inc GST; twin pack $1,980; mudguard bracket $109	$995
Installation	Bolt or adhesive to rear. Minutes. VSB 12 recommends left-hand side	Fitter, minutes	Self-install, 'a few hours', step-mount bracket, universal fit	Self-install
Ongoing ownership	None	Replace when cracked or tarnished	None published	None p
Durability / IP	Sheeting degrades with UV and washing. NO FAULT INDICATION - fails silently	Weatherproof but easily misaligned, cracked, fouled	Resin-filled polycarbonate, die-cast aluminium backplate, OEM waterproof connector	Not pu
AU operating conditions	Retroreflective works at night under headlights, but obscured by dust and degraded by UV	Fail in rain, glare and darkness; foul with dust and road spray	Radar - light-independent; functions in darkness, rain and dust	Radar - light no environ pub
Standards	AS 4001-2003 Pts 1-3; VSB 12; NSW Road Rules 2014 rr 28, 316-1, 316-2. Min 0.125 sq m, letters >=50 mm	ADR 14 / ADR 14/03; UNECE R46	Not stated	Positions fo
Data / telematics	None	None	None	N

OT SENETIL	SGESCO-MAX MAX-SAFE	BRIGADE BACKEYE 360 AI	MOBILEYE SHIELD+	BENDIX BLINDSPOTTER REV.2	PROXICAM
); German-d hardware	SGESCO-MAX, Archerfield QLD (AU)	Brigade Electronics Group PLC (UK)	Mobileye (Intel); AU distribution Fleetsafe	Bendix CVS (Knorr-Bremse, US)	Fleetsafe (AU)
Hz radar	Radar + ultrasonic + sonar + AI camera. INTEGRATOR - sensors from Bosch, Brigade, Continental; SGESCO adds ECU software	4x HD cameras, 360 deg stitch, AI human form recognition	2-8 vision sensors, EyeQ chip, ML classification	Side radar, 1-4 sensors per side, J1939 CAN, speed-adaptive dual mode	HD camera + edge AI, no tags required
warning only)	BOTH - specialises in active (auto-braking)	Passive	Passive	Passive - manufacturer states no brake, steering or throttle intervention	Passive
e blind spot	Side View up to 14 m rearward; Corner View 190 deg arcs on front corners; Reverse ~5 m (brake at 3 m); Front 0.6-3 m	360 deg bird's-eye; 190 x 130 deg per camera	270 deg claimed (vendor)	~3 m lateral. Low speed <32 km/h: 3.6 m longitudinal. High speed: 12 m. 150 deg with CAN	Up to 360 deg from 4 cameras
s, cyclists, ans (vendor aim)	Pedestrians, cyclists, motorcyclists; radar claimed to distinguish object from person	Human form	Pedestrians, cyclists, motorcyclists; ignores inanimate objects	LARGE METALLIC OBJECTS ONLY - manufacturer's own wording. Test target is a 1 ft x 1 ft metal plate	Human form; 99.8% accuracy (VENDOR CLAIM, unverified)
+ audible	Verbal alerts, visual, flashing lights, in-cab screens. Automatic - 'nothing for the driver to remember'	Single monitor, on-screen highlight + audible	Yellow (caution) / red + audio, near-side LCDs	A-pillar LEDs. Audible only when indicator active, and sounds once per activation	HD monitor, up to 4 views
lone	YES - detection-triggered and automatic, not tied to indicator use. Spoken message ('Caution, vehicle turning left') plus LED light bar. Available left and/or right. AMBIGUOUS whether the external speaker is physically directional	None	External speakers available (Shield+ V4)	None	None
inc GST	POA. No published pricing. Foodstuffs required a capex business case approved over two years	POA	POA - est. $4,000-8,000 fitted (assumed)	POA - est. $1,500-3,000 fitted (assumed)	POA
, aftermarket	Dealer-only. Factory-trained heavy-vehicle auto-electricians; calibration and certification; bespoke per body type; 3-6 month development cycle for new applications	Professional; 4 cameras + ECU + PC calibration software	Professional, multi-sensor, calibration	Certified installers. Sensor 559-914 mm above ground, min 457 mm behind mirror, 150 mm clear zone all round	Modular plug'n'play, app-based config
ublished	Lifecycle Maintenance Program: routine checks, preventative maintenance every 2/4/6 years using genuine kits, extended warranty. Standard warranty 12 months	3-year warranty	OTA updates via fleet portal	Not field serviceable - factory sealed	Cloud portal subscription implied
ublished	Not published; ECU self-checks for internal faults	Cameras IP69K; ECU only IP30; -20 to +75 C; 2.8 G vibration; 3-yr warranty	Not published	Factory sealed. IP not published. Self-diagnoses blockage (DTC SPN 950/953, FMI 7)	Ruggedised, lockable DV-Hub, up to 2 TB SSD
t-independent; nmental spec olished	Multi-modal gives partial redundancy. Marketing claims 'all weather conditions'; their own R&D head states cameras degrade in sunlight, darkness and heavy rain	Camera-only; light-dependent; no fouling strategy published	Vision-only; light-dependent; no environmental spec published	Radar - light-independent. Actively self-diagnoses sensor blockage	Camera AI; ruggedised for site use but light-dependent; designed for controlled environments
or ADR 105/00	Designed to comply with UN R151, R158, R159 (design intent, NOT certification). CoR primary duties under the HVNL. No ADR 105/00 claim	UNECE R10, R158; CE, FCC, IC	UN R151 (implied)	FCC Part 15. No ADR 105/00 or UN R151 claim	Workplace WHS, not ADR
lone	Fault monitoring + override	Recordable on Brigade MDR	Fleet portal, heat-maps, OTA updates	J1939 CAN; SafetyDirect via Wingman Fusion pairing	Cloud portal, heat-mapping, 4G/wifi

ATTRIBUTE	DNOTV SIGN (AS 4001)	MIRRORS (ADR 14 BASELINE)	SPOTTO	BLIND SPOT SENETIL
Target user	Any vehicle or combination >=7.5 m needing to straddle a lane to turn. Illegal to display under 7.5 m	All - mandatory	Owner-drivers, small fleets	Owner-drivers, caravans, small fleets
Reference customers	Universal across the Australian fleet; legally recognised	n/a	Jim Pearson Transport	Not published
Market position	Mandatory baseline for outward communication - the incumbent to beat	Mandatory baseline	Budget / DIY	Budget / DIY, compliance-led
Service & support	Any sign maker; none required	Any workshop	AU phone/email, 30-day money back, reseller programme	Single mobile number, Mon-Fri, gmail contact
Failure visibility	SILENT. A faded, dirty or peeling sign looks fine at a glance	VISIBLE. Cracked or missing glass is obvious	Not published	Not published
Key limitation	REARWARD-FACING, ALWAYS ON, REQUIRES READING. The cyclist at the near-side wheels cannot see it, and it says the same thing whether the truck is turning or parked. Addresses overtaking, not blind spots	Human factors, not coverage - the attention budget during a 3-5 second turn; six or more surfaces to scan. The failure is QUANTITY of surfaces, not quality of view	Single side per unit; radar cannot classify VRU type	Overstates ADR 105 pedestrian scope; thin technical publication
Evidence Quality	5	5	2	2

COMPLETE PRODUCT BENCHMARKING TABLE SCORES

Table B3: Existing Product Benchmarking Table Scores

PRODUCT	DNOTV SIGN (AS 4001)	MIRRORS (ADR 14 BASELINE)	SPOTTO	BLIND SPOT SENETIL	SGESCO-MAX MAX-SAFE	BRIGADE BACKEYE 360 AI	MOBILEYE SHIELD+	BENDIX BLINDSPOTTER REV.2	PROXICAM
Detection	1	1	3	3	4	4	5	2	4
VRU communication	2	1	1	1	4	1	2	1	1
Accessibility	5	4	4	4	1	2	2	3	3
AU operating conditions	3	2	4	3	3	2	2	4	2
Driver load	5	4	4	4	4	2	4	4	3
False alarm rate	2	5	3	3	3	3	5	2	3
Physical integration	5	3	3	3	4	3	4	4	2
Raw Score	23	20	22	21	23	17	24	20	18
Weighted score	21.7	18.3	21.2	20.2	21.6	15.8	21.6	18.2	17.6

SGESCO-MAX MAX-SAFE	BRIGADE BACKEYE 360 AI	MOBILEYE SHIELD+	BENDIX BLINDSPOTTER REV.2	PROXICAM
Waste, civil, emergency, logistics and freight, transportation. On-road fleets with capex processes	Municipal, waste, construction fleets	Transit bus, waste, urban fleets	Line-haul tractor and trailer fleets; lane-change assistance	Warehouse, mining, construction (OFF-ROAD)
Cleanaway, Veolia, Suez, Foodstuffs NZ (300-truck grocery fleet), Smart Environmental NZ, Connetics NZ, BMD Constructions	Dulevo Germany, Veritas, E.ON Bioerdgas	VIP Taxi, Polk County Sheriff	Not published; ~decade of deployment claimed	Colas Australia, Aldus, Elite Auto Electrical
Mid-premium ecosystem; adoption driven through CLOCS-A construction procurement	Premium global incumbent	Premium; brand halo from 200M+ vehicles	Established OEM + retrofit incumbent, North America	Premium industrial
National dealer network + dealer portal; head office Brisbane 07 3715 3715	Global installation partners	Dealer/distributor network	1-800 tech line, ACom PRO diagnostics, published troubleshooting manual	AU support portal, Vanta trust centre
ECU self-checks for internal faults and warns on failure	Not published	Not published	BLOCKAGE DTC (SPN 953 right / 950 left, FMI 7); fault = both red and yellow LEDs lit	Not published
ACCESS. Dealer-only, POA, bespoke per body type, capex approval. Unavailable to any operator without a fleet safety manager	ADDS A SCREEN - driver must fixate on a monitor during the turn; ECU only IP30	Cost; positioned for buses; multi-sensor install complexity; vision-only so light-dependent	DETECTS METAL, NOT PEOPLE. Low-speed mode narrows to 3.6 m - the opposite of what a turning manoeuvre needs	Off-road only; not on-road or ADR relevant
3	4	3	5	2

Table B4: Benchmarked Features with Corresponding Weighted Value

AXIS	WEIGHT	MAX POINTS (OUT OF 35)
Detection	16.00%	5.6
VRU communication	22.00%	7.7
Accessibility	22.00%	7.7
AU operating conditions	15.00%	5.25
Driver load	10.00%	3.5
False alarm rate	10.00%	3.5
Physical integration	5.00%	1.75
Total	100.00%	35

A weighted score has been compared and calculated for the different criteria to better reflect the importance of some criteria to road safety between trucks and VRUs.

FAILURE VISIBILITY

Table B5: Comparison of Benchmarked Products Based on Their Failure Feedback to Let the User Know Whether the Product has Stopped Working and Implications

PRODUCT	FAILURE MODE	IS FAILURE VISIBLE?	IMPLICATION
Mirrors	Cracked, missing, tarnished, misaligned or obscured glass	VISIBLE - and inspectable. NHVIM Section 9 lists all of these as rejection grounds	The incumbent's quietest advantage. A driver cannot use a broken mirror without noticing it is broken.
DNOTV sign	Retroreflective sheeting fades under UV; dirt obscures; edges peel	SILENT. A degraded sign looks fine at a glance and nothing prompts the driver to check it	A device that fails silently and is never checked provides false assurance. This is a genuine gap in the incumbent outward-facing device.
Spotto	Not published	Unknown	No published fault indication.
Blind Spot Sentinel	Not published	Unknown	No published fault indication.
SGESCO-MAX	Internal ECU faults	PARTIAL - the ECU self-checks for internal faults and warns on failure. Sensor fouling behaviour not published	Better than most. But internal fault detection is not the same as knowing the lens is dusty.
Brigade 360 AI	Camera or ECU failure; lens fouling	Not published	No published fault indication despite a detailed specification sheet elsewhere.
Mobileye Shield+	Not published	Unknown	No published fault indication.
Bendix BlindSpotter	Sensor blockage by ice, snow, mud or dirt; system fault	VISIBLE AND DIAGNOSED. Blockage raises a DTC (SPN 953 right, SPN 950 left, FMI 7). System fault illuminates both the red and yellow LEDs together	The best implementation in the study, and it directly anticipates the ADR 105/00 fouling requirement.
Proxicam	Not published	Unknown	No published fault indication.

REGULATORY POSITIONING

Table B6: Regulation of Devices and Systems for Trucks in the Current State (as of September, 2026)

DEVICE/SYSTEM	REGULATORY STATUS	REGULATORY BODY	EFFECT ON UPTAKE
Mirrors	MANDATORY	ADR 14 / ADR 14/03; UNECE R46; NHVIM Section 9	Universal. Fitted to every heavy vehicle.
DNOTV sign	MANDATORY (conditional)	NSW Road Rules 2014 rr 28, 316-1, 316-2; AS 4001-2003; VSB 12	Near-universal on vehicles >=7.5 m. Illegal to display under 7.5 m.
Blind spot information systems	BECOMING MANDATORY	ADR 105/00 (F2023L01321). New models 1 Nov 2025; all vehicles 1 Feb 2027	Applies only above 8 t GVM AND over 2,500 mm width. Narrower than it first appears.
Side underrun protection	MANDATORY (new vehicles)	ADR 106/00	Part of the Safer Freight Vehicles package.
Outward audible warning	NOT REGULATED	None identified	No requirement, and no clear permission either - state noise regulations may constrain night operation in residential areas. OPEN QUESTION for NHVR.
CLOCS-A compliance	VOLUNTARY	CLOCS-A scheme, facilitated by NRSPP	Adopted through construction procurement. Reaches construction logistics only.
Chain of Responsibility	MANDATORY (duty, not equipment)	Heavy Vehicle National Law	Creates a general safety duty but specifies no equipment. Large fleets interpret it as requiring investment; small operators do not.

ADR 105/00 CRITERIA

Table B7: ADR105/00 Criteria (Blind Spots) Requirements and Relation to This Research Report and Design Implications

PARAMETER	REQUIREMENT (CURRENT TEXT)
WHAT CHANGED ON 4 MARCH 2026	Amendment 1 altered exactly two clauses: cl 6.2 and cl 6.4.1. Both concern the TEST TARGET. now pins the bicycle target to 'adult bicyclist target in accordance with ISO 19206-4:202 (previously the draft reference 'ISO [CD] 19206-4'). cl 6.4.1 replaces UN R151 para 5.3.2 with stricter Australian requirement for smaller cyclists. Clauses 1.2 and 1.2.1 were repealed as ro housekeeping under Legislation Act 2003 s48D. NOTHING ELSE CHANGED.
Function	To inform the driver of a possible collision with A BICYCLE on the near side, and thereby avo mitigate a collision between a turning vehicle and a bicyclist.
Applicability	Goods vehicles with GVM OVER 8 tonnes AND Overall Width EXCEEDING 2,500 mm. 1 Novem 2025 for new model vehicles; 1 February 2027 for all vehicles. Optional for NB2 not exceedin and/or not exceeding 2,500 mm, and for NC not exceeding 2,500 mm.
NEAR SIDE = RIGHT IN THE TEXT	UN R151 is written for RIGHT-HAND TRAFFIC. Para 1.2 states the requirements 'shall be applie inverting the criteria, when appropriate' for left-hand traffic. Para 2.9 defines near side as RIGHT side for right-hand traffic. The introduction at 0.1 describes 'trucks turning right'.
Speed and light range	Must operate for all forward speeds from standstill to 30 km/h, FOR AMBIENT LIGHT CONDITI ABOVE 15 LUX.
Detection zone - moving	Bicycle at 5-20 km/h, lateral separation 0.9-4.25 m, impact position 0-6 m from the vehicle near-side corner.
Detection zone - near wheel	Also 0.25-0.9 m lateral, longitudinally -0.6 to +0.6 m from the centre of the most forward f wheel while driving straight.
Upper bound	No information signal required if the bicycle is more than 30 m to the rear or 7 m to the fro the near-side front corner, or if TTC exceeds 9 s.
Counter-steer rule	For N2 over 8 t, N3 and M3, the information signal MUST NOT be deactivated because the ve turns away from the bicycle trajectory, as long as a collision is still possible if the driver ste back.
Signal placement	Information signal device located at the near side at a horizontal angle GREATER THAN 3 degrees from an axis parallel to the longitudinal median plane through the ocular referen point. May be reduced if the driver's seat is on the near side.
Two-stage signalling	INFORMATION signal (optical, cannot be manually disabled, deactivates automatically onl failure or sensor contamination) plus a distinct WARNING signal (optical, acoustic, haptic o combination) when collision risk increases. The warning MAY be manually deactivated but reactivate on each activation of the vehicle master control switch.
Warning trigger	Activated at the earliest when the system detects a potential collision - by turn intentio distance, trajectory intersection, indicator activation or similar. IT SHALL NOT DEPEND SOLELY THE ACTIVATION OF THE DIRECTION INDICATOR.
Driver model	Reaction time 1.4 seconds; brake deceleration 5 m/s2.
False positives - minimise	The manufacturer shall ensure the number of false-positive warnings from static non-V objects such as cones, traffic signs, hedges and parked cars is minimised.
False positives - AUSTRALIAN VARIATION	Para 6.7 of Appendix A does not apply. In its place Australia requires demonstration THROU ACTUAL TESTING, or simulation validated by means including actual testing, that the signal i activated when the vehicle passes within 4.25 m lateral of parked cars or traffic cones
Child cyclists - AUSTRALIAN VARIATION (AMENDED 4 MAR 2026)	Para 5.3.2 of Appendix A does not apply. In its place it must be demonstrated that the BS performs as specified for smaller bicycles and bicyclists differing by up to 36 per cent from nominal ISO 19206-4:2020 adult bicyclist target, by (a) physical testing using a CHILD BICYC TARGET to ISO 19206-4:2020, (b) sufficiently validated simulation, or (c) another documen means.

	CLAUSE	WHY IT MATTERS IN THE DESIGN
cl 6.2 20' n a utine	Endnote 4	Every design parameter below survived the amendment unchanged. Your earlier analysis stands - but now it is verified against the compilation, not the as-made version.
oid or	cl. 2.1	Bicycles only. Pedestrians and motorcyclists - two of your four VRU groups - are not what this certifies against. Vendors describing ADR 105 as covering 'bicycle or pedestrian' are overstating it.
nber g 8 t	cl. 3.1-3.3	CONFIRMED in the current text. 2,500 mm is the standard width limit, so a conventional Australian truck over 8 t may fall outside the requirement. Verify the practical effect with NHVR before making it a headline claim.
d by the	App A 1.2, 2.9, 0.1	AUSTRALIA DRIVES ON THE LEFT. Every reference in Appendix A to 'right side', 'front right corner' and 'turning right' must be read as LEFT for an Australian vehicle. The ADR contains NO variation clause spelling this out - it relies on para 1.2. Quote the inversion rule when you cite any 'right side' figure, or your reader will think you have mixed up the sides.
IONS	App A 5.3.1.3	15 lux is roughly deep twilight. A compliant system may lawfully do nothing on an unlit street at 4:30am. Radar is light-independent; cameras are not. Australian freight runs heavily overnight.
e front	App A 5.3.1.4	Your minimum viable detection envelope, free and authoritative.
ront	App A 5.3.1.4	The close-in zone. Hardest for radar because of near-field clutter; easiest for camera.
nt of	App A 5.3.1.4	Detecting beyond this is wasted cost unless justified separately.
ehicle eers	App A 5.3.1	Australian trucks turning into a narrow street often counter-steer away first. The regulation explicitly forbids treating that as 'risk over'. Any concept using simple trajectory logic must handle the counter-steer case.
30 nce	App A 5.4.2	UN R151 para 0.3 reasons this out: about 40 degrees off-axis is visible when the driver glances toward the turn but does not nag when looking ahead. Alert fatigue is designed into the regulation as a first-order concern.
ly on r any must	App A 5.3.1, 5.3.1.2, 5.5, 0.4, 0.5	Mandatory architecture FOR THE DRIVER. Nothing in the regulation requires or provides an equivalent two-stage information-then-warning structure for the VULNERABLE ROAD USER. That asymmetry is the clearest regulatory support for your alarm-versus-information argument.
n, Y ON	App A 5.5.3	Rules out the cheap implementation and requires trajectory or distance evaluation. Note this is exactly the distinction SGESCO make in their own trial write-up, and exactly what Bendix does NOT do.
	App A 5.3.1; Annex 4 para 1.5	CORRECTED CITATION. These figures also appear in Annex 3, but Annex 3 IS EXCLUDED IN AUSTRALIA by cl 6.1. Cite para 5.3.1 (reaction time) and Annex 4 para 1.5 (deceleration), both of which do apply. Getting this wrong would be an easy mark to lose.
RU	App A 5.3.1.5	The basis of your False Alarm Rate axis, stated as an explicit regulatory obligation rather than a nicety.
UGH is NOT .	cl. 6.7, 6.7.1	AUSTRALIA IS STRICTER THAN THE UN HERE. UN R151 allows 'documentation, simulation or any other means to the satisfaction of the Technical Service'. Australia demands physical testing or validated simulation. A genuine local strengthening, and worth citing.
SIS n the CLIST nted	cl. 6.4, 6.4.1	THIS IS THE CLAUSE AMENDMENT 1 CHANGED. Australia is again stricter than the UN, which requires only documentation or simulation to a Technical Service's satisfaction. It also means a compliant system must handle a body roughly a third smaller than an adult - directly relevant if your concept relies on radar cross-section or human-form recognition.

PARAMETER	REQUIREMENT (CURRENT TEXT)
Test target	Adult bicyclist target in accordance with ISO 19206-4:2020. Bicycle reference point is the m forward point on the bicycle centreline. Bicycle width assumed 500 mm (half-width 250 m the lateral separation calculation).
Failure warning	YELLOW optical warning signal, other than or clearly distinguishable from the information sig visible day and night, easily verifiable from the driver's seat, activated with the vehicle mas control switch.
SENSOR CONTAMINATION - REQUIREMENT	Must automatically deactivate if it cannot operate properly because sensing devices ar contaminated by ice, snow, mud, dirt OR SIMILAR MATERIAL, or because ambient light is belo lux. Must indicate this per 5.6.2 and reactivate automatically once contamination clears a normal function is verified.
SENSOR CONTAMINATION - TEST	Contaminate any sensing device COMPLETELY with a substance comparable to SNOW, ICE MUD (E.G. BASED ON WATER). System must deactivate. After complete removal and a mas control switch cycle, it must reactivate within 60 seconds of driving time.
Type-approval test temperature	Ambient temperature during testing shall be between 0 C and 45 C.
Permitted auto-deactivation	Where a vehicle can automatically deactivate the BSIS for operations such as street clean equipment, snowploughs, EMPTYING WASTE CONTAINERS, or bus doors opening outward, t manufacturer must list those situations and criteria. The BSIS must reactivate as soon as t conditions end, and a CONSTANT optical warning must tell the driver it is deactivated.
Protrusion	BSIS external elements may protrude up to 100 mm beyond the width of the vehicle, exce where they form part of another device with its own protrusion limits.
EMC	Must comply with UN Regulation No. 10, 04 series of amendments or later.
Inspection provision	It must be possible to confirm correct operational status by visible observation of the failu warning signal status.
Static test 1	Vehicle stationary. Bicycle dummy perpendicular to the vehicle centreline, impact position m in front of the most forward point, 5 +/- 0.5 km/h. Passes if the signal activates by the ti the gap is 2 m.
Static test 2	Vehicle stationary. Bicycle dummy parallel at 2.75 +/- 0.2 m lateral separation, 20 +/- 0.5 k at constant speed for at least 44 m beforehand. Passes if the signal activates by 7.77 m be the vehicle's most forward point.
Dynamic test - no indicator	During the dynamic test the direction indicators SHALL NOT be operated, and the signal m not activate when passing a speed-limit sign or markers while the dummy is stationary
Test cases LOCKED in Australia	Australia removes the Technical Service's discretion to select additional test cases beyon Table 1, and excludes Annex 3 (the procedure for deriving requirements for other test case
Pre-test conditioning	At the manufacturer's request the vehicle may be driven up to 100 km on mixed urban and roads with traffic and roadside furniture to initialise the sensor system.
Excluded administrative parts	Paragraphs 3, 4, 7, 8, 9, 10 and 11 of Appendix A, and Annexes 1, 2 and 3, do not apply. Referen to 'Technical Service' and 'Type Approval Authority' are replaced by 'Testing Facility' in paras 5.5.3 and 6.1.
Alternative standard	A vehicle may instead meet UN Regulation No. 151, 00 series, including at least Supplements 3.

	CLAUSE	WHY IT MATTERS IN THE DESIGN
ost m in	cl. 6.2; App A 2.12, 2.14	Amendment 1 pinned this to the published 2020 standard rather than the earlier committee draft. If you specify a test regime for your own concept, use the same target.
gnal, ster	App A 5.6.1, 5.6.3	The colour is specified. Do not design a red fault light.
e w 15 nd	App A 5.3.1.6	CORRECTION TO THE EARLIER DRAFT: the phrase 'or similar material' is a catch-all that arguably DOES capture dust. Do not claim the regulation ignores dust. The defensible claim is about the TEST - see the next row. Note also that LOW LIGHT triggers the same auto-deactivation, so a camera system going dark at dusk is compliant behaviour, not a defect.
OR ter	App A 6.9.1, 6.9.2	HERE IS THE REAL GAP, AND IT IS NARROWER AND STRONGER THAN 'THE RULE IGNORES DUST'. The requirement is broad, but the VALIDATION TEST is water-based only. Dry airborne dust behaves differently on a lens or radome from wet mud - it accumulates gradually rather than occluding suddenly, so a system may degrade well below useful performance without ever tripping a threshold tuned for water-based occlusion. Nothing in the standard tests for gradual dry-particulate degradation, and nothing tests for low-angle solar glare at all.
	App A 6.2.2	Note this is the TEST condition, not an operating requirement - the standard sets no operating temperature range. 45 C is a fair Australian summer ambient, but a dark sensor housing in direct sun sits well above ambient, and nothing verifies performance there.
ing he the	App A 5.1	DIRECTLY RELEVANT TO YOUR BENCHMARK. Waste collection vehicles - Cleanaway, Veolia, Suez, the exact fleets SGESCO sells to - are expressly permitted to switch BSIS off during collection. Kerbside collection is precisely when pedestrians are closest. A legitimate and under-examined gap.
pt	App A 5.2.2	Your hard packaging envelope for anything side-mounted.
	App A 5.2.1	Electronics compliance path.
ure	App A 5.7.1	A minimal but real failure-visibility requirement - and more than most benchmarked products provide.
1.15 me	App A 6.6.1	A FRONT cross-traffic requirement, not only a side one. Often missed.
m/h, fore	App A 6.6.2	The overtaking-while-stationary case - a truck stopped at lights with a cyclist filtering up the near side.
ust .	App A 6.5.5, 6.5.8	The test deliberately removes the indicator as a cue, forcing genuine detection. It also builds a false-positive check into the main dynamic test, not just the separate cl 6.7 demonstration.
nd es).	cl. 6.1, 6.6	Australian type approval runs the seven Table 1 cases only. More predictable for a manufacturer, but it also means compliance is demonstrated against a narrow fixed set - a system can pass without being robust across the full declared envelope.
rural	App A 6.3.4	Implies learning or calibration behaviour is expected. Relevant if your concept needs commissioning.
nces s 5.1,	cl. 6.1, 6.3, 6.5, 6.6	Australia keeps the technical requirements and strips the UN type-approval machinery, substituting the RVSA framework.
s 1 to	cl. 7.1	Note the mismatch worth a footnote: cl 7.1 requires at least Supplements 1-3, while Appendix A itself reproduces text up to Supplement 4 (in force 5 June 2023).

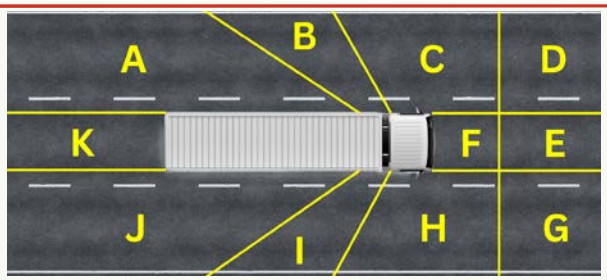
COMPLETE TECHNOLOGY BENCHMARKING TABLE

Table B8: Sensing Technologies Scored Independently of Any Specific Existing Product, 1–5 per criterion. AU Environmental Robustness is a Computed Composite of Darkness, Rain/Fog, Dust, and Glare Rows

CRITERION	CAMERA (VISIBLE)	THERMAL CAMERA	ULTRASONIC	CONVENTIONAL RADAR	4D IMAGING RADAR	LiDAR	RADAR + CAMERA AI	RADAR + THERMAL	UWB	RADAR POSE ESTIMATION
VRU detection	5	5	3	4	5	4	5	5	3	4
Distance & position	3	3	4	5	5	5	5	5	5	4
Movement / velocity	2	2	2	5	5	3	5	5	3	4
VRU classification	5	4	1	2	4	4	5	4	1	3
Detects VRU without a device	5	5	5	5	5	5	5	5	1	5
Darkness performance	2	5	5	5	5	5	4	5	5	5
Rain / fog performance	2	3	3	5	5	2	4	4	5	5
Dust suitability (AU)	2	3	4	5	5	2	4	4	5	5
Low-angle glare tolerance	1	5	5	5	5	3	4	5	5	5
Occlusion / blind-spot capability	1	1	2	2	4	2	3	2	5	4
Retrofit suitability	5	4	5	5	4	3	4	4	4	3
Ease of installation	5	4	5	4	3	2	3	3	4	3
Affordability	5	2	5	4	3	2	3	2	3	2
Technological maturity	5	4	5	5	3	4	4	4	3	2
Future development potential	4	4	2	4	5	4	5	4	5	5
AU ENVIRONMENTAL ROBUSTNESS (computed)	1.75	4	4.25	5	5	3	4	4.5	5	5
Raw Score (/75)	52	54	56	65	66	50	63	61	57	59

APPENDIX E: SURVEY QUESTIONS

Table E1: Participant Classification

SECTION	#	QUESTION	ANSWER TYPE	PURPOSE
1. Demographic	1	Which age group are you?	Multiple choice [Ordinal]	*To understand the demographic of the participants and their experience.*
	2	Please indicate which group describes you best?	Multiple choice [Categorical]	
	3	If truck driver, industry person or other, how long have you been in this role?	Multiple choice [Ordinal]	
2. Blind Spots	4	 Select **all** letters where you think the blind spots are when driving the truck (right hand side drive).	Multiple choice [Ordinal — A, B, C, D, E…]	*To assess participant knowledge regarding blind spots around trucks, compared to Q5a.*
3. Perspective	5	*From your perspective…*		*Understand the beliefs of participants from different perspectives.*
	5a	I am aware of the blind spots around a truck/HGV.	Likert Scale [Disagree → Agree]	
	5b	I believe truck drivers can generally see pedestrians and cyclists around their vehicle.	Likert Scale [Disagree → Agree]	
	5c	I feel confident that current blind spot technologies (mirrors, cameras, sensors) are effective at identifying VRUs.	Likert Scale [Disagree → Agree]	
	5d	I think there is enough awareness among road users about how to manoeuvre safely around trucks.	Likert Scale [Disagree → Agree]	
	6	From your perspective, what are other safety issues around blind spots that should be considered?	Short response	*Identify opportunities for better safety measures around a truck.*
4. Experience	7	*From your experience…*		*Understand the experience participants have had engaging with blind spot safety.*
	7a	I believe low-speed manoeuvres (turning, merging or reversing) are the most dangerous situations for VRUs near heavy vehicles.	Likert Scale [Disagree → Agree]	
	7b	I think driver training adequately prepares drivers to manage blind spots safely.	Likert Scale [Disagree → Agree]	
	7c	I believe cost is a major barrier to improving blind spot safety on heavy vehicles.	Likert Scale [Disagree → Agree]	
	7d	I have personally used or interacted with a blind spot monitoring system (mirrors, cameras, radar, ultrasonic sensors) on or around a heavy vehicle.	Likert Scale [Disagree → Agree]	
	7e	I believe there needs to be more warning for VRUs when they are in truck blind spots.	Likert Scale [Disagree → Agree]	
	8	From your experience, have you ever had a close call or an accident with a vulnerable road user (cyclist/pedestrian/motorcyclist) or truck?	Short response	*Identify interactions participants have encountered with trucks or VRUs.*
5. Knowledge	9	*From your knowledge…*		*Understand the consumer perspective on existing market solutions.*
	9a	There are sufficient products in the current market to keep VRUs safe.	Likert Scale [Disagree → Agree]	
	9b	I think new technology could significantly improve safety around heavy vehicles.	Likert Scale [Disagree → Agree]	
	9c	I am familiar with the different types of blind spot technology currently available for heavy vehicles (e.g. convex mirrors, cameras, sensors).	Likert Scale [Disagree → Agree]	
	10	If you use a product and/or current technology to minimise blind spots, what do you use?	Short response	*Identify what technology gets used by drivers or VRUs today (if any).*
6. Conclusion	11	Is there anything else about truck/HGV blind spots, safety, or your experiences around trucks that you think is important for this research, but wasn't covered by the questions above?	Short response	*To provide participants an option to expand on any thoughts and capture additional qualitative insights.*
	12	Thank you for participating in this survey. If you would also like to participate in a 30-minute online or face-to-face interview please provide your email below and I'll be in contact.	Short response (optional) [Open-ended]	

APPENDIX F: QUANTITATIVE SURVEY DATA

As there was only one industry expert that participated in the survey, they have been excluded from group comparisons. Their responses are reported qualitatively only.

DEMOGRAPHIC

Table F1: Participant Classification

Group	n	%
Truck driver	12	46%
Vulnerable road user (VRU)	13	50%
Industry person	1	4%
Other	0	0%
Total	**26**	**100%**

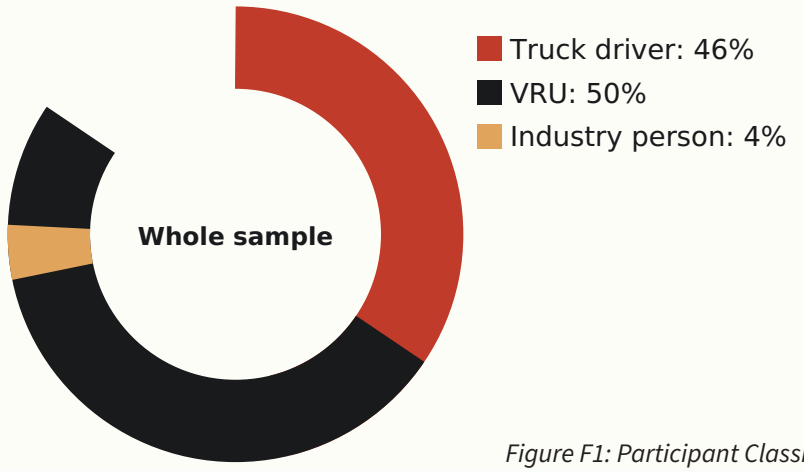


Figure F1: Participant Classification Whole-Sample

Table F2: Age Distribution by Participant Group

	Truck driver n	%	VRU n	%
<20 yrs	0	0%	2	15%
21-30 yrs	1	8%	6	46%
31-40 yrs	2	17%	1	8%
41-50 yrs	3	25%	0	0%
>50 yrs	6	50%	4	31%
Base n	**12**		**13**	

Table F3: Time in Role (Experience)

	Truck driver n	%	VRU n	% (n too small)
<1 yr	0	0%	1	—
1-5 yrs	2	17%	1	—
6-10 yrs	1	8%	1	—
10+ yrs	9	75%	0	—
Base n	**12**		**3**	

BLIND SPOT IDENTIFICATION

Table F4: Full Zone Selection Counts Underlying Figure D2 (✓ = correct zone). Industry person (n=1) Selected: A, B, F, I, J, K — Got 4 of 6 Correct (B, F, I, K), Reported Qualitatively, Not Charted

Zone	Truck driver n	%	VRU n	%
A	2	17%	9	69%
B ✓	12	100%	11	85%
C ✓	9	75%	4	31%
D	0	0%	2	15%
E	0	0%	0	0%
F ✓	9	75%	3	23%
G	1	8%	2	15%
H ✓	2	17%	3	23%
I ✓	5	42%	11	85%
J	1	8%	9	69%
K ✓	10	83%	12	92%

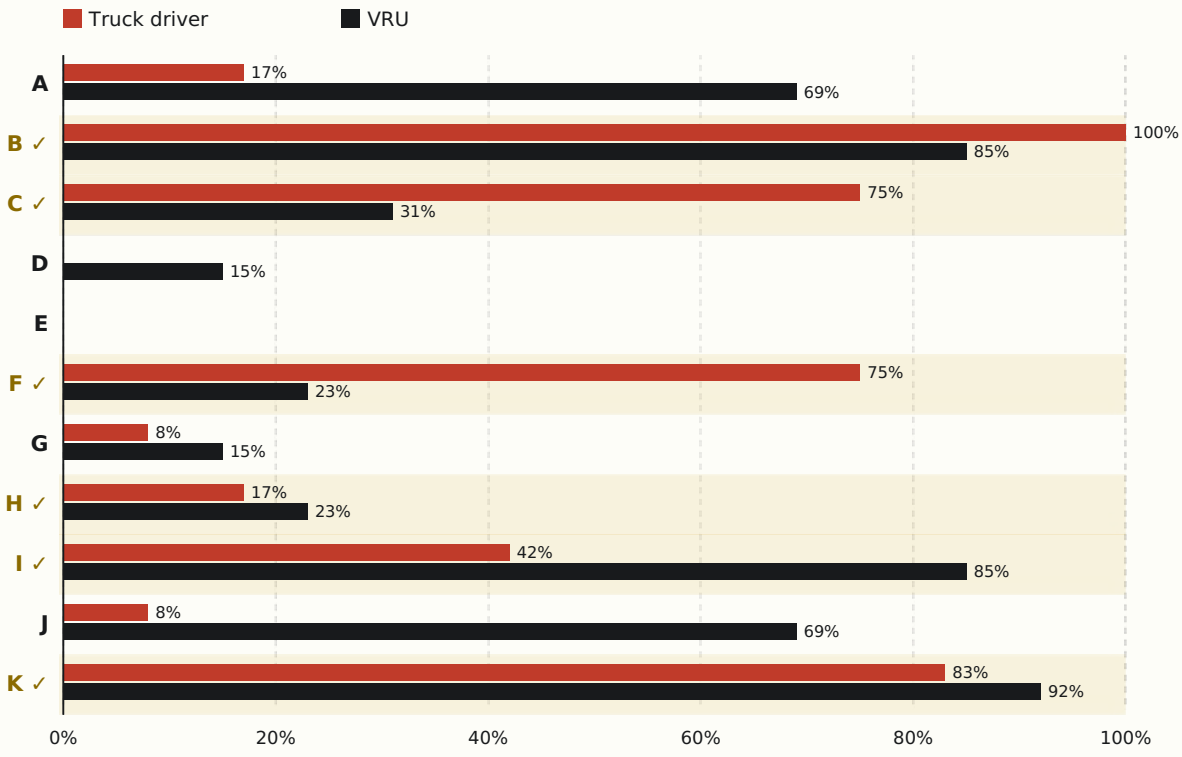


Figure F2: Perceived Truck Blind Spot Zones (A-K) by Respondent Group. Highlighted Rows (B, C, F, H, I & K) are the Correct Zones

PERSPECTIVE SECTION

Table F5: Q5a-d, Whole Sample Count and % of Respondents per Category

	Disagree	Somewhat Disagree	Neither	Somewhat Agree	Agree
Q5a — Aware of blind spots around a truck/HGV	4%	0%	4%	46%	46%
Q5b — Drivers can generally see pedestrians/cyclists	21%	50%	8%	21%	0%
Q5c — Confident current tech effectively identifies VRUs	29%	17%	8%	46%	0%
Q5d — Enough road-user awareness of safe manoeuvring	38%	54%	8%	0%	0%

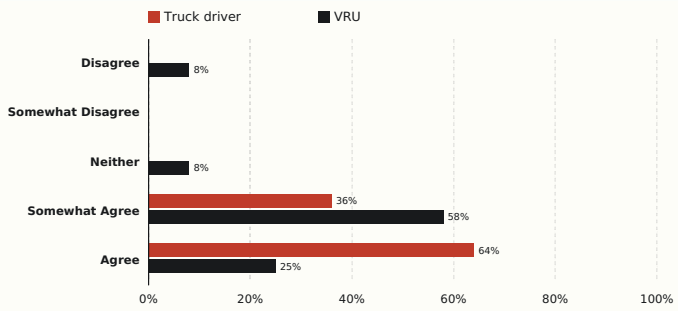


Figure F3: Truck Driver vs VRU, % of Each Group's Respondents per Category, Q5a - "Enough Road-User Awareness of Safe Manoeuvring"

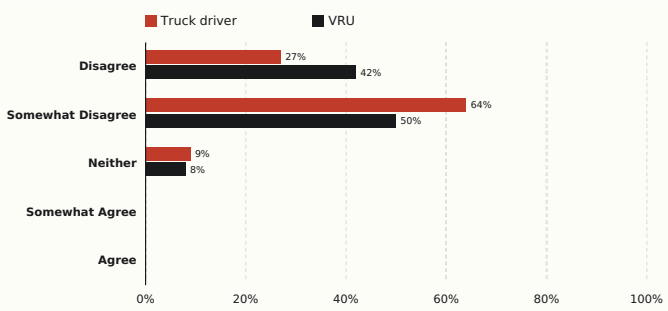


Figure F4: Truck driver vs VRU, % of Each Group's Respondents per Category, Q5d - "Aware of Blind Spots Around a Truck"

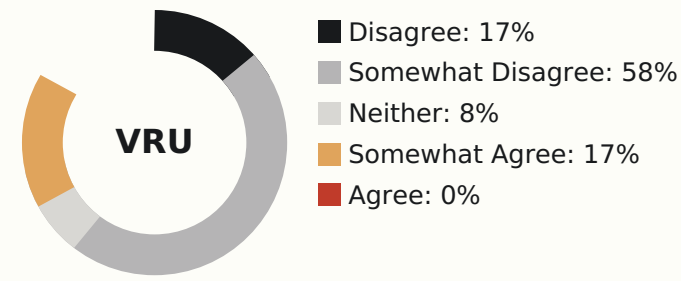


Figure F5: VRU Responses, Q5b - "Truck Drivers can Generally See VRUs"

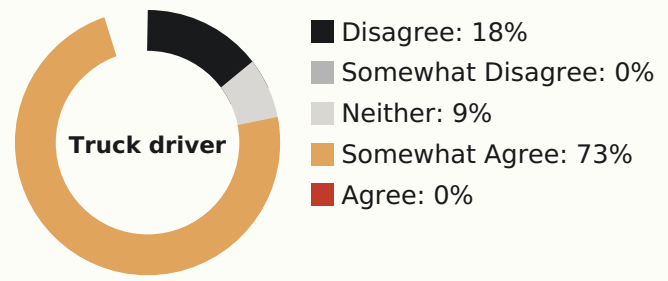


Figure F6: Truck Driver Responses, Q5c - "Confident Current Tech Effectively Identifies VRUs"

EXPERIENCE SECTION

Table F6: Q7a-e, Whole Sample Count and % of Respondents per Category

	Disagree	Somewhat Disagree	Neither	Somewhat Agree	Agree
Q7a — Low-speed manoeuvres are most dangerous for VRUs	4%	13%	22%	52%	9%
Q7b — Driver training adequately prepares for blind-spot mgmt	13%	17%	30%	30%	9%
Q7c — Cost is a major barrier to improving BS safety	9%	17%	35%	30%	9%
Q7d — Personally used/interacted with a BS monitoring system	35%	4%	13%	17%	30%
Q7e — Needs more warning for VRUs in truck blind spots	4%	9%	9%	39%	39%

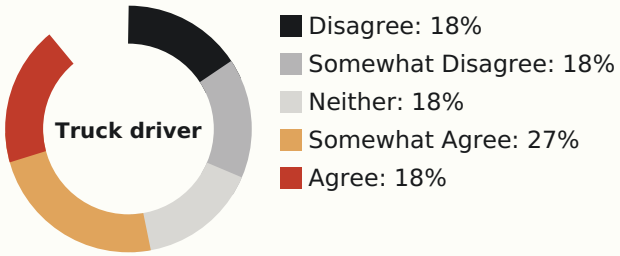


Figure F7: Truck driver Responses, Q7b - "Driver Training Adequately Prepares for Blind-Spot Management"

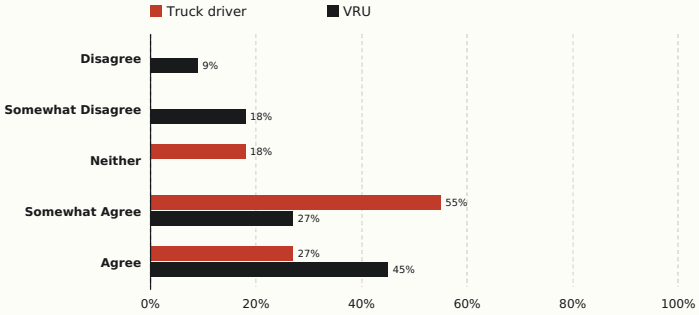


Figure F8: Truck driver vs VRU, % of Each Group's Respondents per Category, Q7e - "Needs More Warning For VRUs in Truck Blind Spots"

Q8 is open free-text, coded Yes/No/Unclear. Shown as two donuts (one per group) — each group's Yes/No/Unclear genuinely sums to 100% of that group.

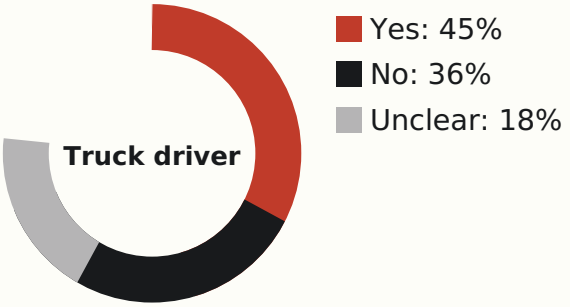


Figure F9: Truck Driver Responses, Q8 - Truck Driver Close-Call/ Accident History

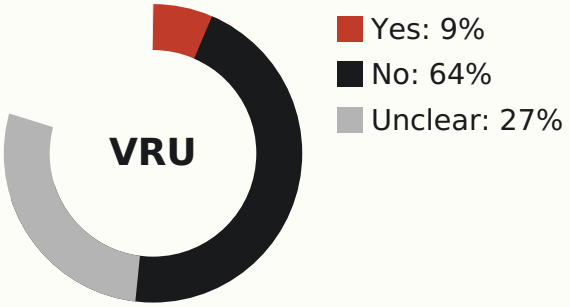


Figure F10: VRU Responses, Q8 - VRU Close-Call/Accident History

KNOWLEDGE SECTION

Table F7: Q9a-c, Whole Sample Count and % of Respondents per Category

	Disagree	Somewhat Disagree	Neither	Somewhat Agree	Agree
Q9a — Sufficient products currently keep VRUs safe	17%	17%	30%	30%	4%
Q9b — New technology could significantly improve safety	9%	0%	17%	48%	26%
Q9c — Familiar with different blind-spot technologies	9%	9%	30%	26%	26%

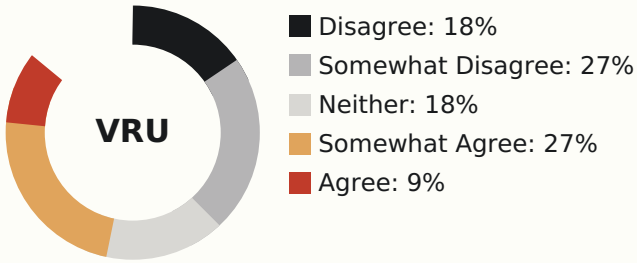


Figure F11: VRU Responses, Q9a - "Sufficient Products Currently Keep VRUs Safe"

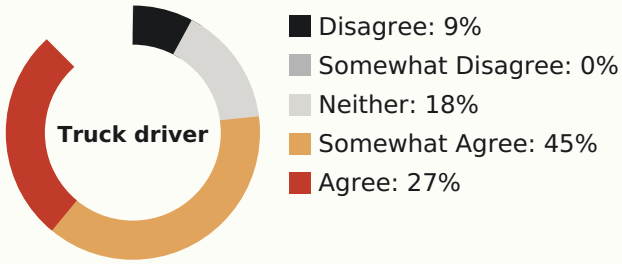


Figure F12: Truck driver Responses, Q7e - ""Familiar with Different Blind-Spot Technologies"

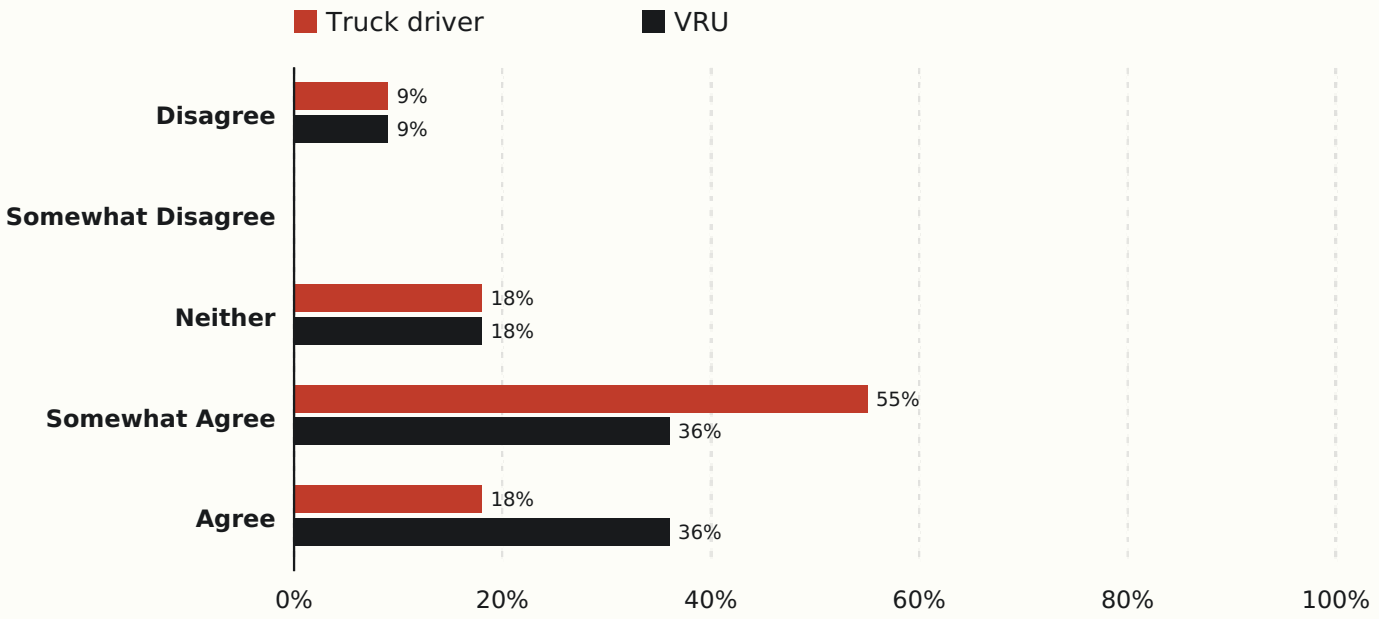


Figure F13: Truck driver vs VRU, % of Each Group's Respondents per Category, Q9b - "New Technology Could Significantly Improve Safety"

KNOWLEDGE SECTION

Q10 is open free-text. It has been coded from the text and grouped inductively into categories (a respondent can mention more than one, so percentages don't add up to 100%).

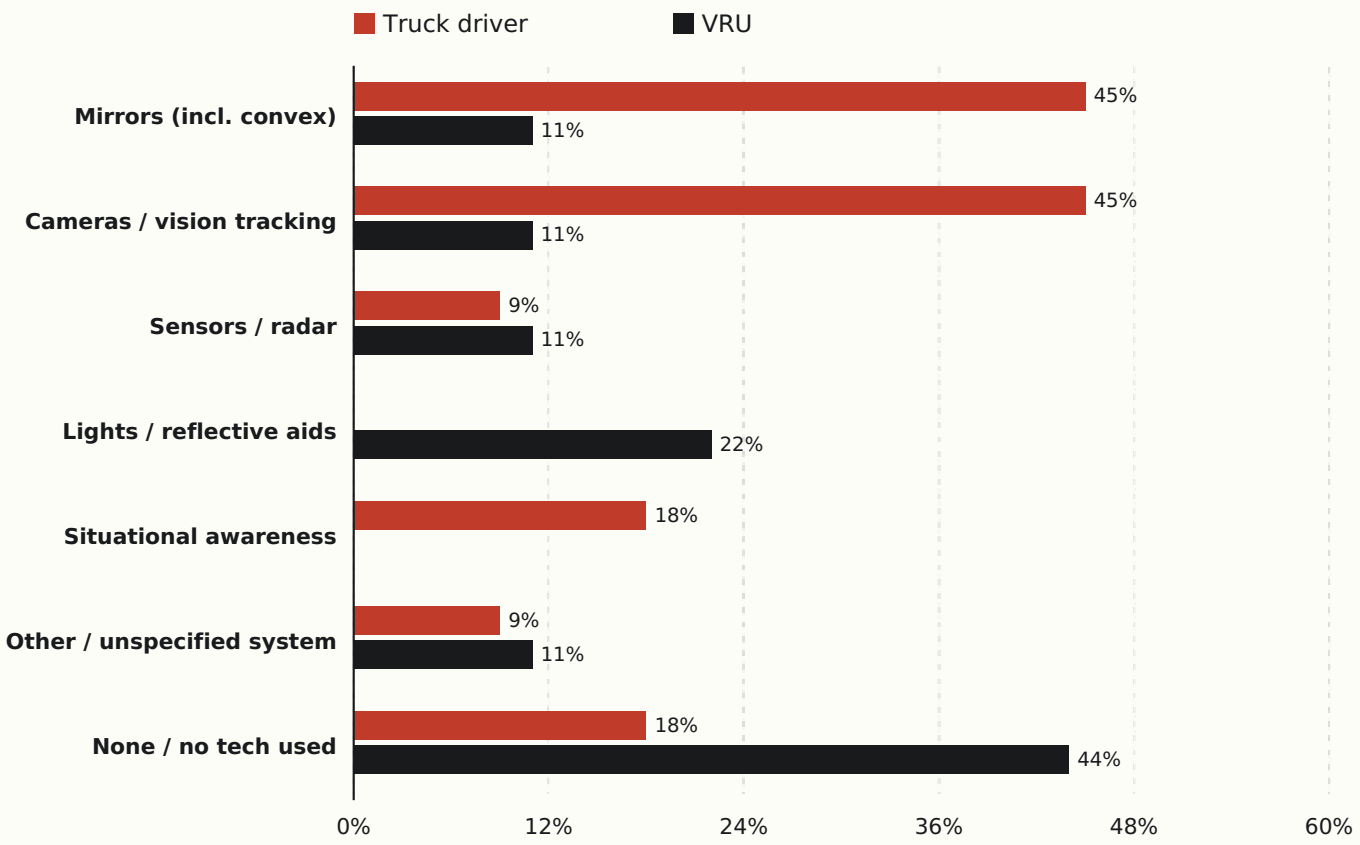


Figure F14: Truck driver vs VRU, % of Each Group's Respondents per Category, Q10 - Technology Currently Used

Table F8: Q10, Coded Categories. Industry Person: Mirrors, Fish-Eye Mirrors, Audible Sensors and Cameras.

Category	Truck driver n	%	VRU n	%
Mirrors (incl. convex)	5	45%	1	11%
Cameras / vision tracking	5	45%	1	11%
Sensors / radar	1	9%	1	11%
Lights / reflective aids	0	0%	2	22%
Situational awareness	2	18%	0	0%
Other / unspecified system	1	9%	1	11%
None / no tech used	2	18%	4	44%

APPENDIX H: QUALITATIVE INTERVIEW DATA THEMATIC

Table H1: Complete Thematic Analysis with 8 Leading Themes

LEADING THEME	GROUP	SUBGROUP	COUNT
LIMITS OF DIRECT VISION	Camera & sensor technology	Camera fouling & maintenance burden	4
		Front-view camera or lens systems	4
		Limited exposure to in-cab screens	4
		Surround-view systems in passenger vehicles	4
		Mirror-replacement camera systems	3
		Reverse camera field-of-view limitations	3
		Sensor fusion and ECU integration	3
		Sensor generation advances (radar and lidar)	3
		Cameras give distance not proximity coverage	2
		Depth perception loss on screens	2
		Device reliability concerns	2
		Environmental robustness already type-tested	2
	Cab design	Front & near-side low blind spots	7
		Passive visibility aids (lower door glazing)	6
		A-pillar obstruction	3
		Cab-over vs bonneted geometry	3
		Front overhead display as a passive aid	3
		Narrow cab & articulation geometry	3
	Mirror limitations	Mirrors as primary trusted reference	5
		Adjacent vehicles invisible despite large mirrors	3
		Blind spot mirrors creating new blind spots	3
		Loss of mirror vision when articulating	2
		Rear blind spot collision	2
DRIVER CAPABILITY & WORKLOAD	Vigilance strategies	Reverse-parking as awareness practice	4
		Active head & mirror scanning	3
		Heightened alertness to erratic road users	3
		Reversing as a stress point	3
		Tracking vehicles before they enter blind spots	2
		Use of a spotter	2
	Workload & fatigue	Demand for low-cognitive-load alerts	5
		Long shifts & assumption-based driving	3

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EXAMPLE QUOTE
"The camera might be dirty or dusty because they don't go around cleaning them because [...] people jump in from one to the other."
"That vision, just a camera in front of the truck that then shows you the image, I think for me that was like straight away, bang, solved. You can see what's in front of your truck."
"Don't use cameras and sensors. My truck. That's all a little bit before its time."
"We also have got a very modern Mercedes [...] that has amazing cameras all around it. It's got all sorts of things that appear back, front, sides, top, down views."
"Mercedes and Volvo now have got rid of [...] outboard mirrors. They now just have a camera there, and [...] in front of the A pillar, they've now just got a vertical TV screen."
"The camera sort of points down rather than a wider, more distant view [...] it doesn't actually give me any sense of where I am in relation to another car behind me."
"In America, they call it fusion, but the idea is the blind spotter works in with the lane departure and the advanced emergency braking, and they're all connected to the one ECU."
"The radars [...] were only 24 gigahertz, whereas the later generation [...] have a 79 gigahertz radar [...] and then lidar and a bunch of other systems came into play as well, and all the sensors that you need for these devices, they got smaller and cheaper."
"They just give a long distance view of what's coming up [...] Not so much as anything close by the confines of the perimeter of the truck."
"We're not used to getting depth out of a TV screen compared to a mirror, like you can get a bit of a depth [...] as to how far things are away from you."
"This is a bloody pain in the ass [...] doesn't always work and doesn't record when it's meant to record."
"That's part of a basic environmental test and usually these things are tested at like negative 40 degrees and in ridiculous heat [...] they've still got quarries in Europe. So I'd be shocked."
"I know from my own experience when driving a truck, particularly cabovers, if someone's standing right in front of the truck, the driver really can't see them."
"I didn't have the ones with the [...] hole in the doors at the bottom where your feet [are], the glass panel, but I think that would have been very handy [...] just to sort of help you cover that spot."
"That A pillar gives you a blind spot in your car, and you can't get away from that because you need something to hold the roof up, I guess."
"My truck's a cab over truck. So blind spots out the front of it are [...] there's very little blind spots in front of me because being cab over, there's no bonnet to look past."
"You've got the truck windscreen, and then you've got this smaller like windscreen over your windscreen [...] a flat sort of image of the person who's standing down there that you wouldn't know that there was a pedestrian in front of your truck if that wasn't there."
"It had a narrow cab, so it introduced so many more blind spots when you're not straight. As soon as you start to bend one of those articulated trucks, you lose so much vision so quick."
"The mirrors are so big in the trucks, you can actually see everything."
"My truck's only 12 metres long, but I can park a Toyota right beside it [...] and you can use that great big mirror and you can't see it. It's just not there."
"Unfortunately, blind spot mirrors also create a blind spot [...] to put another mirror in place."
"The trailers only have to come sort of 15 degrees out from a straight line, and all of a sudden your mirrors don't have a lot of purpose even either."
"A police car went into his rear blind spot. So he didn't see the police car there. So he went to take off, but he rolled back and crushed the police car, the bonnet, and everything."
"If you can reverse park, everybody knows that you're moving. Whereas the first thing you do when you nose into a park, you're going to reverse."
"If I'm not 100% sure, I will sort of wriggle my head around up and down, left and right, and looking in the mirror in all sorts of different directions to get a bigger area."
"Straight away, you're watching her because she's the odd, she's the wild card [...] just being ready to stop at any time because you never know when she was going to stumble."
"Reversing is always a bit stressful to make sure there's [...] what's behind you, or what comes up behind."
"The best way to realise that there's no one in your blind spot is always look behind you or around you and be aware of where the vehicles were before they get into the blind spot."
"That's probably where I'd get my wife to stay out behind me while I do reverse out, just in case you've got that unknown stepping out."
"The old army saying, keep it simple, stupid. Just have a little light that goes on and buzzes just once when it detects [...] just needs to be a simple thing."
"When you're doing a 12-hour shift all day [...] you've got so much going on in your head, you can become complacent."

LEADING THEME	GROUP	SUBGROUP	COUNT
DRIVER CAPABILITY & WORKLOAD	Personal responsibility	Careful driver & vehicle selection	3
		Fear of causing harm	3
		Personal risk discipline	3
		Denial of any personal near-miss	2
	Distraction & complacency	Driver-assist alerts reducing manual vigilance	4
		Phone & screen use while driving	4
		Dependency risk when switching vehicles	2
	Experience development	Increased caution from rising traffic volume	3
		Spatial awareness grows with experience	3
		Skill decay after time away	2
AWARENESS & THE COMPREHENSION GAP	Public understanding of truck limitations	Public unaware of blind spot locations	6
		Signage ineffectiveness ('if you can't see my mirrors')	5
		Misjudging truck braking & acceleration	4
		Pedestrian contact & proximity incidents	4
		Warning signals not understood by the public	4
		Phone use & inattention by pedestrians	3
	Truckers' education	Teaching family members	6
		Blind spots absent from licensing content	4
		Experiential over classroom learning	4
		Devolution of testing to private providers	2
		Drivers as the educable population	2
		Licence progression without drive-time requirement	2
	Educating the public	Early & school-based education	8
		Scale & time limits of education	6
		Information campaigns tied to licensing	3
WARNING & ALERT DESIGN REQUIREMENTS	Alert modality & signal design	Audible signals & comprehension	5
		Proven signal precedents (reversing beepers, horns)	4
		Simplicity over complexity	4
		Visual (light & colour) signalling	4
		Multi-modal in-cab alerting (sound and haptic)	2
	Alert constraints & rejection risks	ADR lighting rules block simple status indicators	4
		Drivers disabling intrusive systems	3
		Low-speed operating context	2
		Startle risk to pedestrians	2

EXAMPLE QUOTE
"I'm very careful. I always make sure I've got a vehicle that I can see around."
"The thing that actually keeps me up at night is running over someone [...] It's not losing my job, it's not losing my licence. It's the fact that I've killed someone."
"I would never put myself in a situation where I felt that I wasn't able to see what I needed to see."
"I've never had a near miss. Not that I know of."
"You can become very complacent with these driver-assist systems because you just rely on them too much."
"People on the phone, people with their music up, all that sort of stuff [...] I've seen people texting while driving."
"When you jump in a different truck that doesn't have it, you don't check your mirrors as much."
"The more traffic there is, the more careful you have to be."
"The more you drive, the more you know where your truck is on the road."
"If I hadn't driven for a while, I'd probably be a bit rusty."
"People just don't know where the blind spots are on a truck."
"That sign that says 'If you can't see my mirrors, I can't see you' — it's a complete lie."
"They don't understand that a truck can't stop like a car."
"I've had people walk into the side of my truck while I was stationary."
"People don't understand what the reversing beeper means [...] they just don't move."
"They're on their phones [...] they're just walking out into the road without looking."
"I've taught my kids [...] I've taught my wife where the blind spots are on a truck."
"It's not in the licence test [...] they don't teach you about blind spots."
"You learn by doing [...] you can't teach that in a classroom."
"The testing has been privatised, and the quality has gone down."
"The drivers are the ones who need to be educated, not the public."
"You can get your licence without actually driving very much at all."
"If you taught kids in school about truck blind spots, they'd remember it for the rest of their lives."
"You can't educate everyone [...] there's just too many people."
"Put it in the licence test for car drivers [...] that would reach everyone."
"A noise is universal [...] everyone understands a noise."
"The reversing beeper has been around forever [...] everyone knows what it means."
"The simpler the better [...] if it's too complicated, people won't use it."
"A flashing light is pretty universal [...] everyone knows what a flashing light means."
"A combination of sound and vibration would be ideal [...] you'd definitely notice that."
"You can't just put any light on a truck [...] there are rules about what lights you can use."
"If it goes off too much, they'll just turn it off."
"Most accidents happen at low speed [...] so the system needs to work at low speed."
"If you make it too loud, you'll scare the pedestrians [...] they might jump in front of the truck."

LEADING THEME	GROUP	SUBGROUP	COUNT
WARNING & ALERT DESIGN REQUIREMENTS	VRU-side detection concepts	Making adoption desirable rather than mandated	3
		Tagging or chipping vulnerable road users	3
		Overhead & external viewpoint concepts	2
VRU SELF-PROTECTION & EXPOSURE	Risk environments & exposure	Intersections as highest-risk points	4
		Cyclists appearing on new roads & terrain	3
		Geographic variation in driver hostility	3
		Urban vs open road risk	3
		Car door opening on cyclist	2
	Self-protection strategies	Avoidance of truck operating zones	4
		Cyclist responsibility for own safety	3
		Defensive riding taught to others	3
		Fear as the primary safety mechanism	3
	Group riding protocols	Ride captains & group discipline	3
		Truck-specific group protocols	3
ROAD USER CULTURE & BEHAVIOUR	Non-compliant & emerging road user behaviour	E-bikes & e-scooters ignoring road law	5
		Gig-economy riders as an emerging hazard	4
		Competitive cyclists breaching road rules	3
		VRUs are not one homogeneous group	3
		Witnessed VRU collision	3
		Committed path — nothing the driver can do	2
	Social norms	Majority of truck drivers are supportive	4
		Perceived professionalism varies by sector	4
		Abuse directed at cyclists	3
		Decline of courtesy between road users	3
		Impatience & cutting in around trucks	3
		Cultural comparison — 'organised chaos'	2
	Attitude to risk	Culture change seen as slow or generational	3
		Fatalism about truck-VRU conflict	3
		Substance use on the road	3
		Learning only through accident	2
ADOPTION & IN-SERVICE FUNCTION	Regulatory & commercial drivers	Blind spots not a current industry or regulator priority	5
		Bonneted trucks fall outside the UN test basis	4
		Difficulty of regulating a diverse fleet	4

EXAMPLE QUOTE
"If you make it something people want, they'll adopt it faster than if you force them to."
"If cyclists had a chip [...] the truck could detect them [...] that would be a game changer."
"A camera on top of the truck looking down [...] you'd see everything around the truck."
"The intersection is where it all happens [...] that's where people get killed."
"You've got cyclists appearing on roads where there never used to be cyclists."
"In some areas, the drivers are much more aggressive towards cyclists."
"In the city, there's just so much more going on [...] the risk is so much higher."
"The car door thing is a real problem [...] people just open their doors without looking."
"I just try to stay away from trucks [...] it's the safest thing to do."
"At the end of the day, you have to look after yourself [...] no one else is going to do it for you."
"I teach my kids to ride defensively [...] always assume the car hasn't seen you."
"Fear keeps you safe [...] if you're not scared, you're not paying attention."
"The ride captain makes sure everyone stays together [...] and stays safe."
"When we see a truck, we all pull to the left and let it pass [...] it's just protocol."
"The e-bike riders [...] they just go wherever they want [...] they don't follow any road rules."
"The Uber Eats guys [...] they're everywhere, they're on the footpath, they're on the road [...] they're a real hazard."
"The lycra guys [...] they think they own the road [...] they run red lights."
"You've got your lycra cyclists, you've got your commuter cyclists, you've got your kids [...] they're all completely different."
"I actually saw a cyclist get hit once [...] it was awful."
"Once they've committed to that path, there's nothing you can do [...] you just have to hope."
"Most truck drivers I know are very aware of cyclists [...] they give them plenty of room."
"The long-haul guys are generally pretty good [...] it's the local delivery drivers that can be a problem."
"I've had things thrown at me [...] I've been yelled at."
"People just aren't as courteous as they used to be [...] everyone's in a hurry."
"Cars cut in front of trucks all the time [...] they have no idea how long it takes to stop."
"In Italy, it's organised chaos [...] everyone knows the rules, even if they look like they're breaking them."
"These things take a generation to change [...] you can't rush it."
"It's always going to happen [...] you can't prevent everything."
"There are people driving under the influence [...] and that makes everything more dangerous."
"People only learn when something goes wrong [...] that's human nature."
"It's just not on the radar [...] no one's talking about it at the industry level."
"The UN tests are designed for European cab-overs [...] our bonneted trucks aren't covered."
"You've got trucks from the 1980s still on the road [...] how do you regulate that?"

LEADING THEME	GROUP	SUBGROUP	COUNT
ADOPTION & IN-SERVICE FUNCTION	Regulatory & commercial drivers	Mandating overseas solutions without local trials	4
		Adoption requires regulation	3
		Commercial & insurance incentives for safety	3
		Divergent UN and North American standards	3
		Government subsidy as an adoption lever	3
		Impending ADR blind spot requirement (Feb 2027)	3
		Layered mandate pathway (ADR, PBS, contracts)	3
		Low Australian volume cannot justify development cost	3
		Workplace status as regulatory leverage	3
		Australian single-regulator advantage	2
		Rating schemes as an adoption lever	2
	Retrofit & integration constraints	Power & mounting on trailers vs rigids	7
		Scaling technology across vehicle combinations	5
		Retrofit systems meet a lower standard	4
		Structural & engineering difficulty of retrofit	4
		Trailer interchange & ownership disconnect	4
		Full compliance requires factory integration	3
		Durability & rough in-service treatment	2
	Fleet age & cost	Cost barrier for owner-operators & small fleets	6
		Fleet turnover lag delays the benefit of mandates	4
		Older fleet lacking modern technology	4
		Cheap, simple retrofit preferred	3
	In-service failure & maintenance	Mandated systems not functioning in service	4
		Fitted-but-failed rate on trailers	3
		No status feedback that a system has failed	3
		Trailer electrical connection failures	3
EVIDENCE & INVESTIGATION GAPS	Crash data & reporting gaps	Fitment not recorded at registration	5
		Driver deaths under-reported relative to other industries	4
		No blind-spot-specific incident statistics	4
		Cannot evaluate whether mandates worked	3
		Raw vs per-capita interpretation of crash data	3
		Reliance on anecdote & word of mouth	3
		Categories of fatality excluded from crash data	2
		Weak methodology in existing safety statistics	2

EXAMPLE QUOTE
"They just copy what Europe does [...] without thinking about whether it works here."
"Without regulation, the industry won't adopt it [...] it's that simple."
"If the insurance companies got behind it [...] that would drive adoption."
"The US has different standards to Europe [...] and we end up in the middle."
"If the government subsidised it [...] even the small operators could afford it."
"There's a new ADR coming in February 2027 [...] that will require blind spot monitoring."
"You could do it through ADR, through PBS, through contracts [...] a layered approach."
"The Australian market is too small [...] manufacturers won't develop something just for us."
"Chain of responsibility is a powerful tool [...] it reaches all the way up the supply chain."
"We've got one national regulator [...] that's actually an advantage when you want to mandate something."
"A star rating system [...] like ANCAP for trucks, that would drive adoption."
"Getting power to a trailer is the problem [...] it's not like a rigid where everything's connected."
"You've got B-doubles, road trains [...] the system has to work across all of them."
"A retrofit is never as good as a factory-fitted system [...] it's always a compromise."
"You can't just bolt something on [...] you have to think about the structural integrity."
"The trailer might be owned by someone different to the prime mover [...] who pays for the upgrade?"
"To do it properly, it has to be built in at the factory [...] retrofit is just a band-aid."
"These things get beaten up [...] they have to be tough to survive in the real world."
"The little guys just can't afford it [...] they're already operating on thin margins."
"It takes 15 years to turn over the fleet [...] so even if you mandate it today, it won't have full effect for a long time."
"Half the trucks out there are so old [...] they don't even have basic safety systems."
"Give me something cheap and simple that I can fit myself [...] that's what the industry needs."
"I've seen plenty of trucks with the system fitted but it doesn't work [...] it's just there to tick the box."
"Half the trailers I've seen with sensors fitted, they don't work [...] they've been knocked off or the wiring's failed."
"There's no way of knowing if the system's working or not [...] there's no warning light."
"The electrical connections between the prime mover and trailer are always failing [...] it's a known problem."
"When you register a truck, there's no field for safety technology [...] we have no idea what's fitted."
"Truck driver deaths are just not counted the same way [...] they're not in the same statistics."
"There's no data on blind spot crashes specifically [...] it's all lumped together."
"We mandated reversing cameras [...] but we have no idea if it actually reduced accidents."
"The raw numbers look bad, but per kilometre travelled, trucks are actually safer than cars."
"Everyone's got a story [...] but there's no data to back it up."
"If a pedestrian dies in hospital three weeks after being hit by a truck [...] it's not counted as a road fatality."
"The statistics are based on police reports [...] which are notoriously unreliable."

LEADING THEME	GROUP	SUBGROUP	COUNT
EVIDENCE & INVESTIGATION GAPS	Crash data & reporting gaps	Worsening road toll	2
	Investigation & learning systems	Absence of no-blame investigation for truck crashes	6
		Crash investigation should record fitment and function	3
		Deep systemic factors missed by current data	3
		Evidence value of onboard recording	3
		Post-crash treatment of drivers versus other modes	3
		An Australian no-blame precedent already exists	2
		Blame culture suppressing information	2
	Evidence on existing safety technology	Limited effectiveness of fatigue-detection technology	3
		Partial benefit better than none	2
		Regulatory Impact Statement as an effectiveness source	2

EXAMPLE QUOTE
"The road toll is going up [...] something's not working."
"We need a no-blame investigation system like aviation [...] so people will actually report what happened."
"Every crash investigation should record what safety systems were fitted and whether they were working."
"The systemic stuff [...] the culture, the pressures [...] none of that shows up in the crash data."
"If every truck had a black box [...] we'd know exactly what happened in every crash."
"A truck driver involved in a fatal crash is treated like a criminal [...] that's not the case in aviation."
"The ATSB does it for aviation and rail [...] there's no reason we can't do it for trucks."
"No one wants to report anything because they're afraid of being blamed [...] so we never learn."
"The fatigue systems [...] they get fooled all the time [...] drivers know how to beat them."
"Even if it only prevents one crash in a hundred [...] that's worth it."
"The RIS for the new ADR has some data on effectiveness [...] but it's based on overseas studies."