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A Review of the Accuracy of Crash Coding When Applied to Motorcycle Crashes

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Abstract

The coding of road crashes is designed to identify patterns of contributing factors for the development of countermeasures. In Australia, crash type is defined by the last vehicle movement before the first crash impact. This coding system was originally based on police data for motor vehicle crashes but did not distinguish between vehicle types. The aim of this study was to examine the accuracy of current crash coding practice when applied to motorcycle crashes. This was a population-based study of 1,479 motorcycle crashes reported in Tasmania between 2013-2016. All crashes were recoded based on details from police reports and the revised codes were compared to those assigned by the road authority. The defining role of the last vehicle movement was suspended in cases where it excluded other prior contributing factors identified in the police report. Almost half of the motorcycle crashes were reclassified to incorporate additional information from the police reports including contributing factors or prior events that are characteristic of motorcycle crashes. These factors had been excluded in the original coding due to the last vehicle movement protocol. The last vehicle movement is not an appropriate method for classifying motorcycle crashes. Training in crash reporting for police and road authorities should include awareness of the different contributing crash factors for different vehicle types and the importance of accurate crash data for the development of targeted countermeasures. The addition of motorcycle specific crash categories and subcodes to the coding systems is also recommended.

Key findings

- The existing crash coding system is not suited for the reporting and analysing of motorcycle crashes nor the development of countermeasures.
- The system cannot be leveraged to its maximum potential due to its reliance on the last vehicle movement before the first crash impact, which excludes prior events typical in motorcycle crashes.
- The system does not provide motorcycle specific subcodes to account for the contributing factors that are characteristic of motorcycle crashes.
- Crashes due to a motorcycle avoiding a collision with another vehicle, are currently coded as single vehicle but should be multi-vehicle.

Introduction

Strategies to reduce the risks and severity of road crashes depend on the accurate identification of contributing factors, risk patterns and population exposure rates. The way

crash data are collected and analysed is critical to correctly identify the most relevant contributing factors for the development of countermeasures. A Safe System crash analysis requires a holistic approach that considers the potential contribution of the road users, their vehicles, the design

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PEDESTRIAN ON FOOT IN TOY / PUSHS	VEHICLES FROM ADJACENT DIRECTIONS (INTERSECTIONS ONLY)	VEHICLES FROM OPPOSING DIRECTION	VEHICLES FROM SAME DIRECTION	MANOEUVRING	OVERTAKING	ON PATH	OFF PATH ON STRAIGHT	OFF PATH ON CURVE	PASSENGER AND MISCELLANEOUS
NEAR SIDE 100	CROSS TRAFFIC 110	1 - WORKING SIDE 2 - OTHER HEAD ON (not overtaking) 120	REAR END 130	1/7 TURN 140	HEAD ON (not side-swipe) 150	PARKED 160	OFF CARRIAGEWAY TO LEFT 170	OFF CARRIAGEWAY RIGHT BEND 180	FELL FROM VEHICLE 190
EMERGING 101	RIGHT FAR 111	RIGHT THROUGH 121	LEFT REAR 131	1/7 TURN INTO PUSHS OBJECT PARKED VEHICLE 141	OUT OF CONTROL 151	DOUBLE PARKED 161	LEFT OFF CARRIAGEWAY INTO OBJECT - PARKED VEHICLE 171	OFF ROAD INTO OBJECT - PARKED VEHICLE 181	LOAD OR MISLE STRUCK VEHICLE 191
FAR SIDE 102	LEFT FAR 112	LEFT THROUGH 122	RIGHT REAR 132	LEAVING PARKING 142	PULLING OUT 152	ACCIDENT ON BROKEN DOWN 162	OFF CARRIAGEWAY TO RIGHT 172	OFF CARRIAGEWAY LEFT BEND 182	STRUCK TRAIN 192
PLACING VEHICLE LATER STANDING ON CARRIAGEWAY 103	RIGHT NEAR 113	RIGHT/LEFT 123	LANE SIDE SWIPE 133	ENTERING PARKING 143	CUTTING IN 153	VEHICLE DOOR 163	RIGHT OFF CARRIAGEWAY INTO OBJECT - PARKED VEHICLE 173	OFF LEFT BEND INTO OBJECT - PARKED VEHICLE 183	STRUCK RAILWAY CROSSING FURNITURE 193
WALKING WITH TRAFFIC 104	TWO TURNING RIGHT 114	RIGHT/RIGHT 124	LANE CHANGE RIGHT (not overtaking) 134	PARKING VEHICLE ONLY 144	PULLING OUT - REAR END 154	FORWARD ON OBSTRUCTION ON CARRIAGEWAY 164	OUT OF CONTROL ON CARRIAGEWAY 174	OUT OF CONTROL ON CARRIAGEWAY 184	PARKED CAR RUN AWAY 194
FACING TRAFFIC 105	RIGHT/LEFT FAR 115	LEFT/LEFT 125	LANE CHANGE LEFT 135	REVERSING 145		TEMPORARY ROADWORKS 165	OFF END OF ROAD 'T' INTERSECTION 175		
ON MEDIAN/FOOTPATH 106	LEFT NEAR 116		RIGHT TURN SIDE SWIPE 136	REAR INTO PUSHS OBJECT - PARKED VEHICLE 146		STRUCK OBJECT ON CARRIAGEWAY 166			
DRIVEWAY 107	LEFT/RIGHT FAR 117		VEHICLES IN PARALLEL LANE LEFT TURN SIDE SWIPE 137	EMERGING FROM DRIVEWAY - LANE 147		ANIMAL (not ridden) 167			
STRUCK WHILE BOARDING OR ALIGHTING VEHICLE 108	TWO LEFT TURN 118			FROM FOOTWAY 148					OTHER 198
OTHER PEDESTRIAN 109	OTHER ADJACENT 119	OTHER OPPOSING 129	OTHER SAME DIRECTION 139	OTHER MANOEUVRING 149	OTHER OVERTAKING 159	OTHER ON PATH 169	OTHER STRAIGHT 179	OTHER CURVE 189	? UNKNOWN 199

1. Definition for classifying accidents (DCA) should be determined by first selecting a column using the text above & then by diagrammatic sub-division.
2. The sub-division chosen should describe the general movement of vehicles involved in the initial event. It does not assign a cause to the accident.
3. Supplementary codes have been defined for most sub-divisions. These codes give further detail of the initial event.
4. The number 1,2 identify individual vehicles involved when the DCA is linked with other vehicle/driver information.
5. These codes were used for 1987 accidents and replace the Road User Movement (RUM) code.

Figure 1. Definitions for classifying accidents (DCA) VicRoads, 2013

and condition of road infrastructure and roads policy (Bliss & Breen, 2020).

Police crash reports are the primary source of data for crash research and policy development purposes. While there are numerous variables potentially involved in motor vehicle crashes, there is a generally agreed, minimum set of data necessary for the investigation of a crash (Austroads, 2015). Data is entered into mandatory report forms designed to ensure all essential and relevant details are recorded. In most jurisdictions, police also provide a sketch and text narrative of the sequence of events, each of which is critical for understanding the contributory factors (Montella et al., 2013).

There is a long history of attempts to find efficient coding systems that combine elements from crash data to identify patterns of human error by road configurations (Andreassen, 1983, 1986; NSC, 1969). Most coding systems (e.g. Definitions for Classifying Accidents (DCA) and Road User Movement (RUM) codes used in Australia), use a matrix of numbered diagrams (approximately 100) that are based on the road user movements and road layout immediately prior to the first impact (Austroads, 2015). Figure 1 is the current matrix used in Victoria and Tasmania.

The columns of the matrix define broad categories such as direction of travel (intersection, opposing or same direction) based on crash type (collision/non-collision). The rows contain sub-codes representing additional details that are characteristic of each category to allow more precise understanding of the events. Similar coding systems are used in Australia, New Zealand, Europe and the United States of America (Montella et al., 2013; NHTSA, 2019). Crash coding is typically undertaken by the road authority.

Crash coding systems may also identify the 'key' vehicle, being that whose last movement most contributed to the crash. Key vehicle status does not determine fault in legal terms but is defined by the road layout and the final vehicle movement before the first crash impact (RTA, 2005; TMR, 2023). Figure 2 shows three examples of codes in which a vehicle turns right across the path of another (Austroads, 2015). In each of these configurations, the turning vehicle is defined as the key vehicle (highlighted bold) because they turned into the path of another vehicle regardless of whether it had right of way (e.g., at traffic lights).

Coding systems with key vehicle analysis can be a most useful tool for understanding what happened in a crash. This is important because it can identify patterns in the failure to avoid a collision that are characteristic of specific road layout types (Austroads, 2015; Montella et al., 2013).

The original coding systems were based on data from motor vehicle crashes, most of which involved cars (92%) at that time (RTA, 1997). In consequence the crash kinematics of other vehicles were not considered in the coding system (Austroads, 2015). The question now is whether these codes are suitable for classifying other vehicle crashes, particularly motorcycles (Rowden et al., 2008; Vicroads, 2014).

The limitations of the last movement before the crash for classifying motorcycle crashes was first raised by Andreassen (1986). He noted that single vehicle 'out of control' crashes often involved other factors including avoiding another vehicle. He argued that such cases should properly be classified as multi-vehicle or the role of other factors such as animals or objects on the road be noted (Andreassen, 1986). The 'last movement' criteria have also been identified as failing to accurately identify factors in

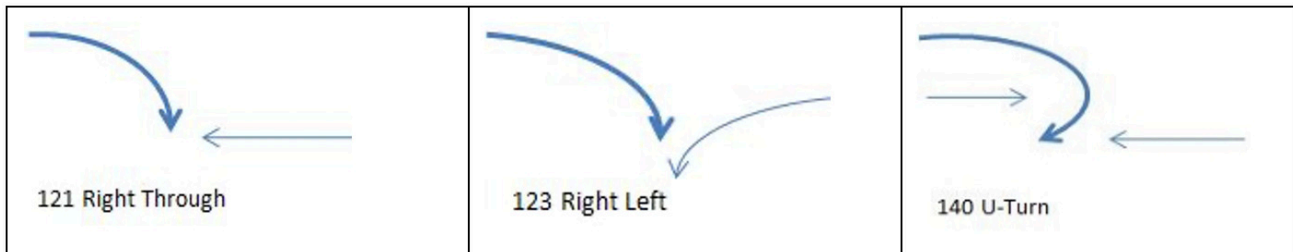


Figure 2. Definitions for Classifying Accidents (DCA) Codes (Austroads, 2015)

Note: Key vehicle in bold

pedestrian crashes (Afroza et al., 2022) with similar limitations likely for crashes involving cyclists and personal mobility device users (e.g., e-scooter).

The aim of this study was to determine whether the current crash coding (DCA) system and specifically the defining focus on the last vehicle movement, accurately identifies the key factors in motorcycle crashes. The objective was to ensure the coding system maximised the potential benefits of crash data for the development of targeted countermeasures within a Safe System approach.

Method

Data for motorcycle crashes ($n=1,590$) reported between 1 April 2013 and 31 December 2016 and the text narratives from their police reports¹, were provided by the Tasmanian Department of State Growth. To be eligible for inclusion in the study, crashes were required to have been transport-related, on public roads and with police text narratives available. The objective of the analysis was to compare the DCA codes assigned to crashes in the Department's dataset with details provided in the police text narratives (Austroads, 2015). A researcher, with an extensive experience in motorcycle crash investigations, crash coding systems and analysis of administrative crash data conducted the review. This involved using the DCA coding system to classify each crash, based on the police text narratives. Web-based maps and photographs of the crash location were used to clarify road layout or other relevant details of crash site locations where necessary ([Google.com.au/maps/place](https://www.google.com.au/maps/place), [Google.com/earth/](https://www.google.com/earth/)).

It became apparent that there was a systematic disparity between the coding based on the police reports and the coding in the Department's dataset. These disparities typically involved events where a motorcycle rider crashed while trying to avoid a collision with another vehicle, animal or object on the road. Current coding practice classifies such cases as being due to loss of control, which describes the vehicle's final movement before the first impact. It was therefore decided that, for the purposes of this study,

the last vehicle movement as the defining basis for classification, would be suspended for those crashes where additional contributing factors had been identified. The revised coding (DCA-R) therefore included any precipitating factors mentioned in the police narratives that were available as categories or subcodes within the coding system. New variables were also added to distinguish single (SVC) from multi-vehicle (MVC) crashes, and to identify the key vehicle in multi-vehicle crashes as either the rider (MVC-R) or the other driver (MVC-D). Key vehicle status was assigned to each multi-vehicle crash where coding had been revised. The revised DCA-R codes were merged into the Department's crash dataset using their unique crash identification numbers.

To illustrate the recoding process, the following example is from a crash originally coded 'Off path on straight' with subcode '179 Other straight'². Using information from the police narrative, the crash was recoded to 'On path', subcode 'Struck animal (not ridden)'. The revised coding describes a very different event where the motorcycle struck an animal on the carriageway, the rider lost control and crashed off the road.

Results

The text narratives identified 111 crashes that were outside the study criteria. These had occurred either on private property, racetracks, off-road trails, beaches, during rider training or police chases. The final dataset consisted of 1,479 cases, which represented 93 percent of all motorcycle crashes ($n=1,590$) reported between 1 April 2013 and 31 December 2016.

The review resulted in the recoding of 47 percent of the crashes ($n=693/1,479$) to incorporate details from the police narrative. Over half of the revised crashes ($n=394/693$, 57%) remained within the original category, but with different sub-codes.

[Table 1](#) compares the original and revised categories for all recoded crashes. The revised coding includes three DCA categories** (Adjacent, Opposing and Same direction), that

¹ Police text narratives for crashes were not available in digitised format prior to April 2013.

² Figure B7 (Austroads, 2015)

had not been used in the original coding. Most of the cases recoded to these three categories had originally been classified as single vehicle crashes, despite the presence of another vehicle being identified in the police narrative. They included crashes that had been originally coded as: 'Off path on curve' (n=36); 'Off path on straight' (n=74) and 'On path' (n=4).

The limitations of the reliance on last movement in the coding system are evident in those crashes where the classification excluded events that occurred prior to the last movement before the crash. The suspension of the last movement protocol resulted in the crash category being changed in 59 percent of all crashes (n=878/1479) and sub-codes changed for 47 percent (n=689/1479) including 43 percent where both were changed (n=299/689).

The 59 percent of crashes recoded to other DCA categories, included 102 (originally classified) single vehicle crashes, being reclassified as multi-vehicle due to another vehicle having played a significant role. [Table 2](#) shows the original DCA category for the revised crashes whose category and sub-codes changed. These recoded crashes included: Same direction (n=38), subcode 'Rear end' (n=25/38); Manoeuvring (n=30), subcode 'Emerging from driveway' (n=8/30), Opposing directions (n=24), subcode 'Head on (not overtaking)' (n=16/24).

[Table 3](#) shows the crashes where the original crash category was correct but the most appropriate subcodes had not been applied, presumably due to the last movement protocol.

[Table 4](#) shows the distribution of crashes by injury severity comparing the relative proportions of those crashes that were or were not recoded. The coding for 76 percent of fatal crashes and 70 percent of property damage only (PDO) crashes, did not require revision, whereas over half of those involving serious (53%) or minor injury (55%) were recoded.

[Table 5](#) shows the key vehicle status in the ten most frequent crash types that were recoded. The motorcycle was the key vehicle in 74 percent of all rear end crashes including 25 cases reclassified from single vehicle 'off path' where the rider crashed while avoiding the rear of another vehicle. The other driver was in the key vehicle in almost all of the single vehicle crashes (n=15/16), reclassified as 'Head-on (not overtaking)' where the motorcycle rider crashed while avoiding another vehicle that was on the wrong side of the road.

Discussion

An important feature of the study method was the decision to incorporate any precipitating events, which occurred prior to last vehicle movement, into the coding of crashes. Such events would not normally be included under current crash coding practice. The results demonstrate the relevance of such pre-crash events and their importance in accurately capturing the factors leading to motorcycle crashes.

The key finding is that using the last vehicle movement before the first crash impact, as the basis for classifying motorcycle crashes, is inappropriate and misleading due to the

different crash kinematics of one and two track vehicles. Motorcycles are more manoeuvrable but less stable than the two track vehicles for which the coding system was devised. In particular, motorcycles are more likely to overturn or skid when making sudden changes of direction or hard braking such as to avoid a collision (Kováčsová et al., 2020). Focusing on the final movement fails to account for prior events that may have caused the motorcycle rider's loss of control. It explains why coders appeared to ignore the evidence from the police narratives which, when included, resulted in almost half of all motorcycle crashes being reclassified.

This review has identified a serious flaw in the DCA crash coding system when applied to motorcycle crashes, which is the systemic exclusion of critical information that is essential to the development of targeted countermeasures. In particular, the system has been shown to exclude subcodes that represent factors, such as road surface conditions, that have been identified as significant risk factors for motorcycles (Milling et al., 2016; Rowden et al., 2008; Sun et al., 2020; Wu et al., 2018). In effect, current coding practice creates a picture of motorcycle crash causes that often exclude road related factors. This inadvertently distorts understanding of crash causes, placing more responsibility on rider behaviour and less on other road users and those responsible for the safety of road infrastructure. By minimising the importance of road conditions this also undermines arguments about the need to make roads safer for motorcycles.

The primary purpose of a crash coding system is to make more effective use of the data. The objectives are to standardise definitions and to facilitate understanding of characteristic patterns to support analysis for the development of countermeasures (Andreassen, 1983). Characteristic patterns are identified by standardising and combining the different elements of crash type, collision diagrams and contributing factors (Andreassen, 1983; Montella et al., 2013). Whereas all details from police reports are recorded and available from road authority databases, these comprise a far greater volume of separate variables and present a significant challenge for analysts to independently search for patterns. There may also be less incentive to explore raw data given the apparent lack of new patterns emerging for motorcycle crashes identified over decades by the current coding practice.

The outcome of this review suggests an urgent need to review current crash coding practice to better leverage data for the identification of targeted countermeasures for motorcycle crashes. More accurate data are critical to the development of a Safe System, particularly in relation to infrastructure design and maintenance, which have become contentious issues in the motorcycle safety debate (OECD/ITF, 2015; VTI, 2021; WHO, 2022).

While some modifications to the current DCA system are recommended, major change may not be necessary. The focus on last movement before the first impact must be abandoned, at least for motorcycle crashes, and additional motorcycle specific subcodes should be included. Others, concerned about pedestrian crashes, have suggested that

Table 1. Distribution of crashes recoded from original DCA to DCA-R based on details from police reports 2013-2016 (n=693/1479)

Revised DCA Category (DCA-R)	Original DCA Category							Total N	Col %
	Manoeuvring	Off Path on curve	Off Path on straight	On Path	Overtaking	Passenger & Misc.	Pedestrian		
Manoeuvring	5*	3	21	1	-	-	-	30	4.3
Off path on curve	4	326*	22	2	-	-	-	354	51.0
Off Path on straight	4	66	43*	5	-	-	-	118	17.0
On-Path	4	21	47	11*	-	1	-	84	12.0
Over taking	-	2	6	-	12*	-	-	20	2.9
Passenger & Miscellaneous	1	2	3	-	-	2*	-	8	1.2
Pedestrians	-	-	1	1	-	-	1*	3	0.4
Adjacent directions **		7	6	-	-	-	-	13	1.9
Opposing directions**	1	17	5	1	-	1	-	24	3.5
Same direction**	1	5	32	1	-	-	-	39	5.6
All revised crashes	20	449	186	22	12	3	1	693	100

*Indicates cases in the correct category but recoded to sub-codes within the original DCA category (n=394)

**Indicates categories not applied in the original coding

Table 2. Crashes recoded to different DCA category with associated subcodes (n=296)

Count of CrashId DCADesc	Manoeuvring n=20	Off Path on Curve n=123	Original_DCA Category			Total N=296
			Off Path on straight n=142	On Path n=10	Passenger & miscellaneous n=1	
Adjacent directions (n=13)						
110 – Cross Traffic	-	-	2	-	-	2
111- Right Far	-	3	1	-	-	4
112- Left Far	-	1	-	-	-	1
113- Right Near	-	-	1	-	-	1
116- Left Near	-	2	2	-	-	4
119- Other Adjacent at Intersection	-	1	-	-	-	1
Opposing directions (n=24)						
120- Head on (not overtaking)	1	13	2	-	-	16
121- Right-through	-	1	3	-	-	4
123- Right-right	-	1	-	-	-	1
129- Other Opposing direction	-	2	-	1	-	3
Same direction (n=38)						
130- Rear end	-	3	22	-	-	25
132- Rear right	-	1	1	-	-	2
134- Lane change right	-	-	3	-	-	3
135- Lane change left	-	-	6	-	-	6
136- Right turn side swipe	-	1	-	-	-	1
137- Left turn side swipe	1	-	-	-	-	1
Manoeuvring (n=30)						
140- U-turn	-	-	3	-	-	3
142- Leaving parking	1	-	3	-	-	4
143- Entering parking	1	-	-	-	-	1
147- Emerging from driveway	3	1	3	1	-	8
149- Other Manoeuvring	-	2	12	-	-	14
Overtaking (n=8)						
151- Out of control	-	2	4	-	-	6
152- Pulling out	-	-	2	-	-	2

Count of CrashId DCADesc	Manoeuvring n=20	Off Path on Curve n=123	Original_DCA Category			Total N=296
			Off Path on straight n=142	On Path n=10	Passenger & miscellaneous n=1	
On Path (n=74)						
160- Parked	1	-	-	1	-	2
161- Double parked	-	-	1	-	-	1
164- Permanent obstruction	1	-	1	-	-	2
165- Temporary roadworks	-	5	3	-	-	8
166- Struck object	2	9	22	-	1	34
167- Struck animal (not ridden)	-	7	11	-	-	18
169- Other On Path	-	-	9	-	-	9
Off path on straight (n=76)						
170- Off carriageway to left	-	1	1	-	-	2
171- Left off carriageway into object	-	5	-	1	-	6
172- Off carriageway to right	-	3	-	-	-	3
173- Right off carriageway into object	-	2	-	3	-	5
174- Out of control on carriageway	4	52	-	1	-	57
179- Other Off Path Straight	-	3	-	-	-	3
Off path on curve (n=27)						
180- Off carriageway right bend	-	-	6	-	-	6
181- Off carriageway on right bend into object	3	-	2	-	-	5
182- Off carriageway left bend	-	-	6	-	-	6
183- Off carriageway on left bend into object	-	-	2	1	-	3
184- Out of control on carriageway	1	-	5	1	-	7
Passenger and miscellaneous (n=6)						
190- Fell in/from vehicle	-	1	2	-	-	3
191- Load or missile struck vehicle	-	-	1	-	-	1
193- Struck railway crossing furniture	1	1	-	-	-	2
Total	20	123	142	10	1	296

Table 3. Crashes correctly coded under the original DCA category whose subcodes were revised to include contributing factors and other relevant information not included in original coding (n=391)

DCA-R Categories with revised Subcodes	Original DCA Category				Total
	Off Path on curve	Off Path on straight	On Path	Overtaking	
Overtaking (n=12)					
151- Out of control	-	-	-	5	5
152- Pulling out	-	-	-	5	5
153- Cutting in	-	-	-	2	2
On Path (n=11)					
160- Parked	-	-	1	-	1
164- Permanent obstruction	-	-	1	-	1
165- Temporary roadworks	-	-	1	-	1
166- Struck object	-	-	1	-	1
167- Struck animal (not ridden)	-	-	7	-	7
Off Path on straight (n=43)					
170- Off carriageway to left	-	7	-	-	7
171- Left off carriageway into object	-	8	-	-	8
172- Off carriageway to right	-	2	-	-	2
173- Right off carriageway into object	-	1	-	-	1
174- Out of control on carriageway	-	23	-	-	23
175- Off end of road or T intersection	-	1	-	-	1
Off path on curve (n=326)					
180- Off carriageway right bend	95	-	-	-	95
181- Off carriageway on right bend into object	40	-	-	-	40
182- Off carriageway left bend	129	-	-	-	129
183- Off carriageway on left bend into object	26	-	-	-	26
184- Out of control on carriageway	36	-	-	-	36
Total crashes	326	42	11	12	391

Table 4. Distribution of crashes by injury severity that had required recoding (n=1,479)

DCA Revised	Fatal		Serious injury		Minor injury		First aid only		Property damage only		Total	
Yes	6	24%	144	53%	353	55%	86	44%	104	30%	693	47%
No	19	76%	128	47%	292	45%	110	56%	237	70%	786	53%
All crashes	25		272		645		196		341		1479	

focusing on the movements of both types of road users together with current DCA codes, instead of only on collisions, could provide greater insights to inform targeted countermeasures (Afroza et al., 2022).

There are some additional sub-codes specific to motorcycle crash factors provided in the NSW Road User Movement (RUM) coding system, but not available in the DCA coding used in Tasmania and Victoria (Austroads, 2015). These include four subcodes for crashes off curves, allowing for the direction of travel (left/right) and the direction of the curve (left/right). This level of detail is meaningful when investigating a motorcycle crash but may be of less relevance to a car crash. Other motorcycle-specific crash

risk factors should also be added such as road surface conditions including skid resistance, potholes and debris (Milling et al., 2016; Vicroads, 2014). It should be noted there are separate DCA codes provided for pedestrian and bicycle crashes, but none for motorcycle crashes. However, as for motorcycle crashes, the limitations created by the last vehicle movement crash coding practice is likely to also apply to these road users.

A limitation of the study method relates to the reclassification process being conducted by one person. However, this is comparable to the situation for road authority coders who also rely on police reports. The key difference in coding outcomes was due to the suspension of the first movement

Table 5. Key vehicle in 10 most frequent multi-vehicle crashes by revised DCA Category and sub-code Tasmania 2013-2016 (n=531)

DCA-R	Key Vehicle				Total	
	Other Driver		Motorcyclist			
110 Cross traffic	58	70%	25	30%	83	16%
113 Right Near	22	92%	2	8%	24	5%
120 Head on (not overtaking)	39	53%	34	47%	73	14%
121 Right-through	54	84%	10	16%	64	12%
130 Rear end	40	26%	112	74%	152	29%
132 Rear right	9	32%	19	68%	28	5%
139 Other Same direction	7	30%	16	70%	23	4%
140 U-turn	19	95%	1	5%	20	4%
147 Emerging from driveway	26	76%	8	24%	34	6%
152 Pulling out	12	40%	18	60%	30	6%
Total	286	54%	245	46%	531	100%

protocol for cases where prior contributing factors were available, but which had been excluded by the first movement protocol in the original coding. A further limitation to our findings is that this study is based on the coding practice in one State, which may not reflect practice in other jurisdictions.

Finally, crashes where motorcycles crashed while avoiding a crash with another vehicle, should be classified as multi-vehicle crashes (Andreassen, 1983), with additional subcodes for the precipitating event avoided (e.g., Rear end (avoided) and Head-on (avoided)). It is essential that crash type is correctly established with single and multi-vehicle crashes modelled separately for motorcycles. It is only then that the contributing factors and potential countermeasure can be accurately identified (Geedipally & Lord, 2010; Jonsson et al., 2007; Montella et al., 2012; Savolainen & Mannering, 2007).

Conclusions

These findings provide compelling evidence that the crash coding systems used in Australia do not accurately represent motorcycle crashes nor provide a sound basis for valid analysis or reporting. The study has revealed systematic bias in the coding of motorcycle crashes, which may mislead efforts to develop appropriate countermeasures, particularly those relating to road infrastructure design and maintenance.

Provided crash causes are accurately understood, there are well established tools for identifying and addressing road environments where motorcyclists are more or less likely to misjudge or underestimate the potential hazards present (Milling et al., 2016; MSAC, 2014; Vicroads, 2014). Accordingly, it is recommended that:

- A working party of stakeholders be established to review current crash coding practices with specific reference to the last vehicle movement and its appropriateness to motorcyclists.

- Jurisdictions using coding systems based on the last vehicle movement for classifying crashes (DCA and RUM codes) to review their current coding practices and the implications when applied to motorcycle crashes.
- Coding of crash type for motorcycles to be based on an assessment of the contributory movement of all road users present, including other vehicles where no crash impact occurred between the vehicles.
- New motorcycle specific subcodes be added to include precipitating crash factors, to more accurately identify patterns of road user error and contributing factors from the road environment, such as those currently provided for pedestrian and cyclist crashes.
- Training in crash reporting and coding for police and road authorities to be designed to raise awareness and understanding of the contributing factors and crash kinematics associated with different road user groups.

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Author Contributions

Liz de Rome conceived, designed and conducted the analysis and wrote the paper. Tom Brandon contributed to the preparation and analysis of the data. Chris Hurren revised the work critically for intellectual contents.

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Human Research Ethics Review

The study (Project 2019-461) was referred to and exempted from ethical review by the Human Research Ethics Committee of Deakin University, because all data was from pre-existing collections which had been de-identified and, accordingly, met the definition of posing negligible risk.

Conflicts of interest

The authors declare there is no conflict of interest.

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References

- Afroza, S., Debnath, A. K., Ghabraie, K., & Sobhani, A. (2022). Can movement types provide better insights than DCA (Definitions for Classifying Accidents) codes for crashes involving pedestrians? *43rd Australasian Transport Research Forum (ATRF)*.
- Andreassen, D. C. (1983). Standard accident definitions: primary accident classes and accident types. *Australian Road Research*, 13(1), 10–24.
- Andreassen, D. C. (1986). *A Review of Victorian RUM Codings, 1975–84*. Australian Road Research Board (ARRB).
- Austroroads. (2015). *Guide to road safety: part 8: treatment of crash locations* (Nos. AGRS08–15). Prepared by Turner, B., Tziotis, M., Hillier, P., Beck, D., & Makwasha, T.
- Bliss, T., & Breen, J. (2020). *Country guidelines for the conduct of road safety management capacity reviews and the specification of lead agency reforms, investment strategies and safe system projects*. World Bank Global Road Safety Faculty. <https://openknowledge.Worldbank.Org/entities/publication/6b432c7c-da9e-58c5-b770-1c9cdcd66579>
- Geedipally, S. R., & Lord, D. (2010). Investigating the effect of modeling single-vehicle and multi-vehicle crashes separately on confidence intervals of Poisson–gamma models. *Accident Analysis & Prevention*, 42(4), 1273–1282. <https://doi.org/10.1016/j.aap.2010.02.004>
- Jonsson, T., Ivan, J. N., & Zhang, C. (2007). Crash prediction models for intersections on rural multilane highways: Differences by collision type. *Transportation Research Record*, 2019(1), 91–98. <https://doi.org/10.3141/2019-12>
- Kováčová, N., Grotoli, M., Celiberti, F., Lemmens, Y., Happee, R., Hagenzieker, M. P., & de Winter, J. C. (2020). Emergency braking at intersections: A motion-base motorcycle simulator study. *Applied Ergonomics*, 82, 102970. <https://doi.org/10.1016/j.apergo.2019.102970>
- Milling, D., Affum, J., Chong, L., & Taylor, S. (2016). *Infrastructure improvements to reduce motorcycle casualties* (No. AP-R515–16).
- Montella, A., Andreassen, D., Tarko, A. P., Turner, S., Mauriello, F., Imbriani, L. L., & Romero, M. A. (2013). Crash databases in Australasia, the European Union, and the United States: review and prospects for improvement. *Transportation Research Record*, 2386(1), 128–136. <https://doi.org/10.3141/2386-15>
- Montella, A., Aria, M., D'Ambrosio, A., & Mauriello, F. (2012). Analysis of powered two-wheeler crashes in Italy by classification trees and rules discovery. *Accident Analysis & Prevention*, 49, 58–72. <https://doi.org/10.1016/j.aap.2011.04.025>
- Motorcycle Safety Advisory Council (MSAC). (2014). *Making roads motorcycle friendly: A New Zealand guide for roading asset owners, designers & maintenance contractors*. NZ Transport Agency. <https://www.msac.org.nz/assets/Uploads/pdf/Making-Roads-Motorcycle-Friendly-NZ-September-2014-V2.pdf>
- National Highway Traffic Safety Administration (NHTSA). (2019). *2018 FARS/CRSS coding and validation manual annual report* (p. 828). National Centre for Statistics and Analysis.
- National Safety Council (NSC). (1969). *Manual on classification of motor vehicle traffic accidents* (H. S. R. Institute, Ed.; 6th ed.). Transport Research Board.
- OECD/ITF. (2015). *Improving safety for motorcycle, scooter and moped riders. International Transport Forum* (Prepared by Holgate, J., Redant, K., de Solere, H., van Elslande, P., Margaritis, D., Yannis, G., de Craen, S., Haslie, L.I., Muguero, J., Grummas Granstrom, P.O., La Beaumelle, V.F.). OECD Publishing.
- Roads and Traffic Authority (RTA). (1997). Road traffic accidents in NSW - 1997 statistical statement: Year ended 31 December 1997. In R. S. T. M. Directorate (Ed.), *Road and Traffic Authority*. Road and Traffic Authority.
- Roads and Traffic Authority (RTA). (2005). *TADS - traffic accident database system data manual* (Roads and Traffic Authority, Ed.; p. 125).
- Rowden, P., Steinhardt, D., & Sheehan, M. (2008). Road crashes involving animals in Australia. *Accident Analysis & Prevention*, 40(6), 1865–1871. <https://doi.org/10.1016/j.aap.2008.08.002>
- Savolainen, P., & Mannering, F. (2007). Probabilistic models of motorcyclists' injury severities in single- and multi-vehicle crashes. *Accident Analysis & Prevention*, 39(5), 955–963. <https://doi.org/10.1016/j.aap.2006.12.016>
- Sun, S., Zhou, B., & Zhang, S. (2020). Analysis of factors affecting injury severity in motorcycle involved crashes. In *CICTP 2020* (pp. 4207–4219). <https://doi.org/10.1061/9780784482933.361>

Transport and Main Roads (TMR). (2023). Guide to coding crashes. In Department of Transport and Main Roads (Ed.), *State of Queensland*.

VicRoads. (2013). *CrashStats, Road Crash Statistics: Victoria, User Guide, 2008 Edition*.

Vicroads. (2014). *Making roads motorcycle friendly: A guide for road design, construction and maintenance*. Department of transport and planning. <https://www.vicroads.vic.gov.au/safety-and-road-rules/motorcyclist-safety/making-roads-motorcycle-friendly>

VTI. (2021). Riding in a safe system - workshop on safety for powered-two-wheelers. Final report from a workshop held on 9-23 June 2021. In Å. Forsman, J. Jansson, S. Forward, R. Nuruzzaman, I. Skogsmo, & A. Vadeby (Eds.), *Recommendations for better motorcycle safety based on international experts* (p. 72). Swedish National Road and Transport Research Institute (VTI).

World Health Organization (WHO). (2022). *Powered two-and three-wheeler safety: A road safety manual for decision-makers and practitioners, second edition*. Geneva.

Wu, D., Hours, M., & Martin, J. L. (2018). Risk factors for motorcycle loss-of-control crashes. *Traffic Injury Prevention*, 19(4), 433–439. <https://doi.org/10.1080/15389588.2017.1410145>