



# **Factors Contributing to One-Vehicle and Two-Vehicle Crashes at Intersections and Mid-Blocks**

*Sara Bahrolloom,  
Postgraduate Research Student  
School of Business, Latrobe University  
03 June 2014*

# Contents:

- Research Background
- Data Analysis
- Results
- Discussion of Results
- Conclusion

# Research Background

- ✓ Traffic accidents are a leading cause of death and serious injuries in many countries.
- ✓ Each year in Australia there are more than (Australian Automobile Association , 2013):
  - 600,000 reported road crashes
  - 200,000 reported injuries
  - 22,000 serious injuries requiring long-term care and treatment
  - 1,700 people killed in road crashes
- ✓ Intersections are a common place for crashes (Abdel-Aty and Keller, 2005). This can be due to:
  - the number of different conflicting manoeuvres and/or their design characteristics.
  - Severe crashes, such as angle crash, are likely to occur at intersections

# Research Background

- ✓ Several studies have been conducted to investigate factors affecting number and severity of crashes at intersections (Abdel-Aty and Keller, [2005](#), Wong and Li, [2007](#), Wang and Abdel-Aty, [2008](#))
- ✓ Literature review of safety analysis shows that there are a number of studies carried out to explore safety of non-intersections ([Roudsari et al. 2007](#); [Moore et al. 2011](#)).
- ✓ Abdel-Aty ([2003](#)) has investigated the effect of human, vehicle and road and environmental characteristics on crash severity and compared the significant variables at intersections and non-intersections.

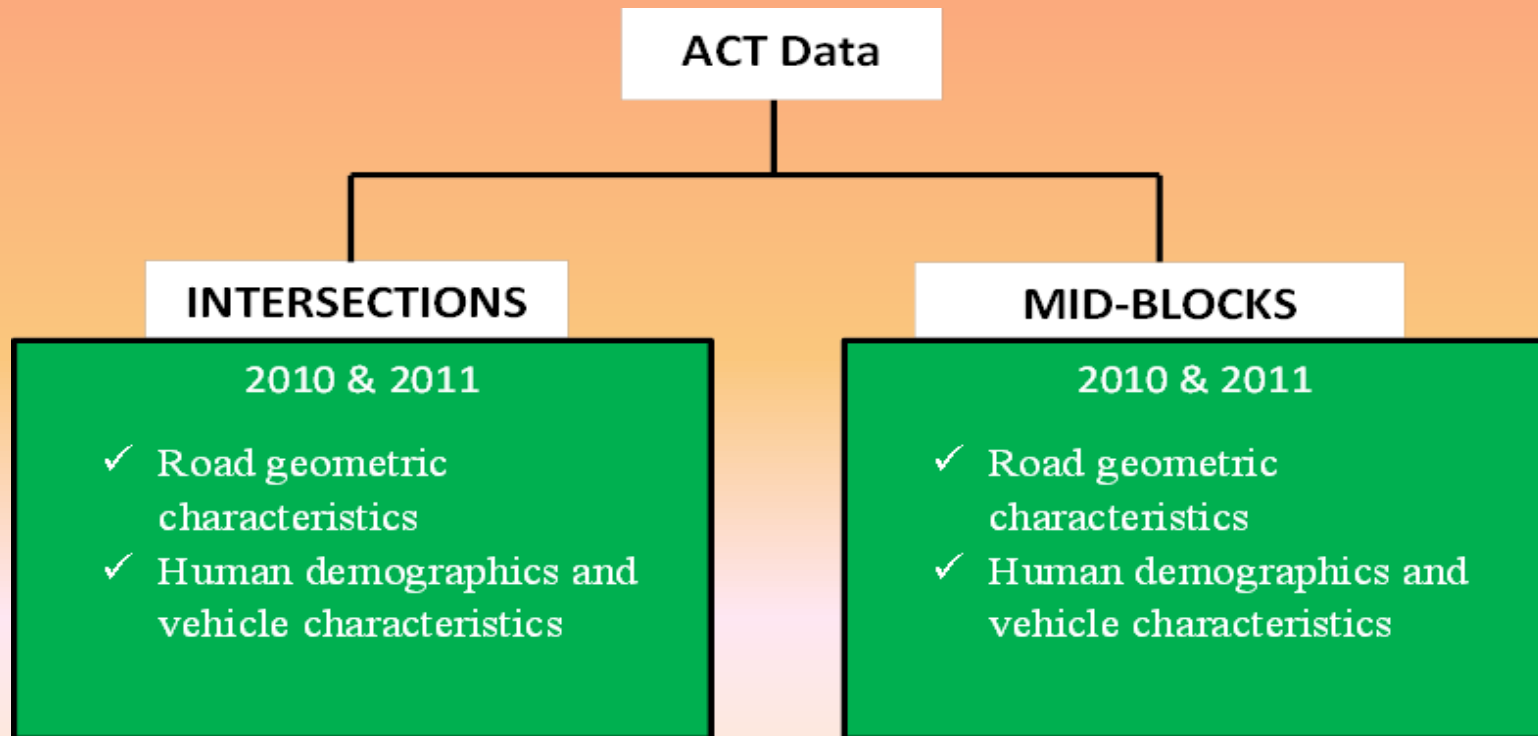
**Knowledge Gap:** There is not enough consideration to compare factors affecting crash at intersections and mid-blocks in previous studies.

# Contents:

- Research Background
- Data Analysis
- Results
- Discussion of Results
- Conclusion

# Data Analysis (Data)

- ✓ Australian Capital Territory (ACT) crash data has been used in this study. The total number of **intersection crashes** is **9445** and the total number of **mid-blocks crashes** is **6778**.



# Data Analysis (Data)

## Road Geometry Related Variables

<b>Variables</b>	<b>Levels</b>
<b>Accident Type</b>	1: Head on collision, 2: Rear end collision, 3: Right angle collision, 4: Right turn into oncoming vehicle, 5: Side swipe collision, 6: Others
<b>Road Condition</b>	1: Good dry surface, 2: Loose surface, 3: Muddy or oily surface, 4: Snow or ice, 5: Unknown, 6: Wet surface
<b>Fixed Object Struck</b>	1: Building or structure, 2: Guide post, 3: Kerb or guard rail, 4: Light or tele-pole, 5: Not Applicable, 6: Other, 7: Sign or signal pole, 8: Tree
<b>Fixed Object Located On</b>	1: East side of road, 2: Island, 3: Median, 4: North side of road, 5: Null, 6: Other, 7: South side of road, 8: Unknown, 9: West side of road, 10: Not applicable
<b>Weather Condition</b>	1: Fine, 2: Rain, 3: Cloudy, fog or smoke, 4: Others
<b>Intersection/Mid-Block Location Type</b>	1: Cross intersection, 2: Multiple intersections, 3: Other, 4: Roundabout, 5: T intersection, 6: Y intersection, 7: Median opening, 8: Non median opening
<b>Traffic Control Code</b>	1: Control not operated, 2: Give way sign, 3: Marked pedestrian crossing, 4: Other, 5: Police, 6: School crossing, 7: Stop sign, 8: Traffic lights, 9: Uncontrolled, 10: Unknown
<b>Lighting Condition</b>	1: Dark - good street lighting, 2: Dark - no street lights, 3: Dark - poor street lighting, 4: Daylight, 5: Semi-darkness, 6: Unknown
<b>Road Type</b>	1: Bridge, 2: Construction site, 3: Driveway or lane, 4: Normal road, 5: Other off road, 6: Parking area, 7: Private property, 8: Ramp, 9: Commuter cycle way, 10: Null
<b>Road Angle</b>	1: Curve (severe), 2: Curve (Slight), 3: Straight, 4: Not applicable, 5: Null
<b>Road Grade</b>	1: Crest, 2: Level or slight grade, 3: Steep grade, 4: Unknown

# Data Analysis (Data)

## Vehicle and Driver Related Variables

<b>Variables</b>	<b>Levels</b>
<b>Vehicle1 Lane Code</b>	1: Straight lane, 2: Left-turn lane, 3: Right-turn lane, 4: Merge lane, 5: Other, 6: Unknown
<b>Vehicle1 position</b>	1: Approaching intersection, 2: Into driveway, 3: Not related to intersection, 4: Out of driveway, 5: Unknown, 6: Within intersection
<b>Vehicle1 Movement</b>	1: Left-turn, 2: Right-turn, 3: Straight ahead, 4: Overtaking left side, 5: Overtaking right side, 6: Other, 7: Unknown
<b>Vehicle1 Action</b>	1: Changing lane, 2: Parking (into/out), 3: Unknown, 4: Other, 5: Out of control, 6: Proceeding normally, 7: Slowing, 8: Stopped
<b>Driver1 License Class</b>	1: Any motor cycle, 2: Heavy bus, 3: Car, 4: Heavy truck, 5: Light truck, 6: Light bus, 7: Unknown, 8: Null
<b>Driver 1 Gender</b>	1: Female, 2: Male, 3: Null, 4: Unknown
<b>Vehicle1 Type</b>	1: Bus, 2: Car or station wagon, 3: Truck, 4: Taxi, 5: Other, 6: Unknown
<b>Vehicle1 Visibility Restriction</b>	1: Obstructed, 2: Not obstructed, 3: Null
<b>Driver 1 Age</b>	1: Missed, 2: 16-25, 3: 26-45, 4: 46-65, 5: >65
<b>Vehicle2 Lane Code</b>	1: Straight lane, 2: Left-turn lane, 3: Right-turn lane, 4: Merge lane, 5: Other, 6: Unknown
<b>Vehicle2 Position</b>	1: Approaching intersection, 2: Not related to intersection, 3: Into/out of driveway, 4: Unknown, 5: Within intersection, 6: Null
<b>Vehicle2 Movement</b>	1: Left-turn, 2: Right-turn, 3: Straight ahead, 4: Overtaking left side, 5: Overtaking right side, 6: Other, 7: Unknown
<b>Vehicle2 Action</b>	1: Changing lane, 2: Parking (into/out), 3: Unknown, 4: Other, 5: Out of control, 6: Proceeding normally, 7: Slowing, 8: Stopped
<b>Driver 2 License Class</b>	1: Any motor cycle, 2: Heavy bus, 3: Car, 4: Heavy truck, 5: Light truck, 6: Light bus, 7: Unknown, 8: Null
<b>Driver 2 Gender</b>	1: Female, 2: Male, 3: Null, 4: Unknown
<b>Vehicle2 Type</b>	1: Bus, 2: Car or station wagon, 3: Truck, 4: Taxi, 5: Other, 6: Unknown
<b>Vehicle2 Visibility Restriction</b>	1: Obstructed, 2: Not obstructed, 3: Null
<b>Driver 2 Age</b>	1: Missed, 2: 16-25, 3: 26-45, 4: 46-65, 5: >65

# Data Analysis

## (Analysis Method)

- In the combined data base, the dependent variable is “intersection/mid-block” which indicates whether the crash takes place at intersection or mid-block.
- In the first step the Pearson Chi-Square test ([Levine et al. 2008](#)) is performed to find out the significant independent variables influencing the dependent variable .
- In the second step a Binary Logistic Regression model is developed in order to explore the relative importance of the significant variables.

$$P_i = \frac{\text{EXP}(\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_k X_{k,i})}{1 + \text{EXP}(\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_k X_{k,i})}$$

Where:  $\beta_0$  is the model constant and  $\beta_1, \dots, \beta_k$  are the unknown parameters associated with independent variables ( $X_k, k=1, \dots, K$  the set of independent variables).

# Contents:

- Research Background
- Data Analysis
- Results
- Discussion of Results
- Conclusion

# Two-Vehicle Crashes: Results (Chi-Square)

<i>Dependent Variable</i>	<i>Explanatory Variables</i>	<i>Significance Level (Pearson Chi-Square test with 95% level of confidence)</i>
Intersection/Mid-Block	Accident Type	<0.0001
	Road Condition	0.010
	Fixed Object Struck	<0.0001
	Fixed Object Located On	<0.0001
	Weather Condition	0.547
	Intersection/Mid-Block Location Type	<0.0001
	Traffic Control Code	<0.0001
	Lighting Condition	<0.0001
	Road Type	<0.0001
	Road Angle	<0.0001
	Road Grade	<0.0001
	Vehicle1 Lane Code	<0.0001
	Vehicle1 position	<0.0001
	Vehicle1 Movement	<0.0001
	Vehicle1 Action	<0.0001
	Driver1 License Class	0.016
	Driver 1 Gender	<0.0001
	Vehicle1 Type	<0.0001
	Vehicle1 Visibility Restriction	<0.0001
	Driver 1 Age	0.572
	Vehicle2 Lane Code	<0.0001
	Vehicle2 Position	<0.0001
	Vehicle2 Movement	<0.0001
	Vehicle2 Action	<0.0001
	Driver 2 License Class	<0.0001
	Driver 2 Gender	<0.0001
	Vehicle2 Type	<0.0001
	Vehicle2 Visibility Restriction	<0.0001
Driver 2 Age	0.050	

# Two-Vehicle Crashes: Results (Binary Logistic Regression)

Level of The Dependent variable (i)	Independent variable ( $X_{ki}$ )	Significance Level (Wald Statistic)	Level of The Variable	Parameters ( $\beta_i$ )	Odd Ratio (Exp $\beta_i$ )
Mid-Block	Accident Type	<0.0001	Rear end collision	1.938	6.948
			Right angle collision	-6.372	0.002
			Right turn into oncoming vehicle	-3.589	0.028
			Side swipe collision	4.705	110.463
			Others	-3.166	0.042
	Vehicle 1 Movement	0.007	Right turn	-1.520	0.219
			Straight ahead	2.227	9.276
			Overtaking left side	1.467	4.335
			Overtaking right side	1.814	6.134
			Other	3.742	42.193
	Vehicle 1 Visibility Restrictions	0.003	Not obstructed	-1.730	0.177
	Vehicle 2 Position	<0.0001	Not related to intersection	7.23	1380.889
			Into/out of driveway	9.076	8744.263

# Two-Vehicle Crashes: Results (Binary Logistic Regression)

Level of The Dependent variable (i)	Independent variable ( $X_{ki}$ )	Significance Level (Wald Statistic)	Level of The Variable	Parameters ( $\beta_i$ )	Odd Ratio ( $Exp \beta_i$ )	
Mid-Block	Vehicle 2 Movement	0.013	Right turn	0.379	1.461	
			Straight ahead	-0.422	0.656	
			Overtaking left side	-1.005	0.366	
			Overtaking right side	2.574	13.115	
			Other	3.741	42.127	
	Vehicle 2 Action	<0.0001	Parking (into/out)	-2.610	0.074	
			Unknown	-2.213	0.109	
			Other	-0.577	0.561	
			Out of control	0.496	1.642	
			Proceeding normally	2.289	9.868	
	Driver 2 Age	0.004	Slowing	-1.429	0.239	
			Stopped	1.404	4.073	
				16-25 years old	2.034	7.641
				26-45 years old	2.966	19.416

# Two-Vehicle Crashes: Results (Binary Logistic Regression)

Level of The Dependent variable (i)	Independent variable ( $X_{k,i}$ )	Significance Level (Wald Statistic)	Level of The Variable	Parameters ( $\beta_i$ )	Odd Ratio ( $\text{Exp } \beta_i$ )
Mid-Block	Road Angle	0.006	Curve (slight)	5.576	264.087
			Straight	5.182	178.127
	Constant	0.001	Constant	-11.945	0.0001

# One-Vehicle Crashes: Results (Chi-Square)

<i>Dependent Variable</i>	<i>Explanatory Variables</i>	<i>Significance Level (Pearson Chi-Square test with 95% level of confidence)</i>
Intersection/Mid-Block	Accident Type	<0.0001
	Road Condition	0.177 ←
	Fixed Object Struck	<0.0001
	Fixed Object Located On	<0.0001
	Weather Condition	0.083 ←
	Intersection/Mid-Block Location Type	<0.0001
	Traffic Control Code	<0.0001
	Lighting Condition	<0.0001
	Road Type	0.176 ←
	Road Angle	<0.0001
	Road Grade	0.012
	Vehicle1 Lane Code	<0.0001
	Vehicle1 position	<0.0001
	Vehicle1 Movement	<0.0001
	Vehicle1 Action	<0.0001
	Driver1 License Class	0.020
	Driver 1 Gender	0.291 ←
	Vehicle1 Type	<0.0001
	Vehicle1 Visibility Restriction	0.235 ←
	Driver 1 Age	0.021

?

# One-Vehicle Crashes: Results (Binary Logistic Regression)

Level of The Dependent variable (i)	Independent variable ( $X_{k,i}$ )	Significance Level (Wald Statistic)	Level of The Variable	Parameters ( $\beta_i$ )	Odd Ratio (Exp $\beta_i$ )
Mid-Block	Traffic Control Code	0.025	Marked pedestrian crossing	4.698	109.754
			Traffic lights	0.776	2.173
			Uncontrolled	3.292	26.897
			Unknown	1.739	5.690
	Lighting Condition	0.011	Dark-no street lighting	2.517	12.386
			Dark-poor street lighting	1.718	5.573
			Day light	-0.623	0.536
			Semi-darkness	0.416	1.516

# One-Vehicle Crashes: Results (Binary Logistic Regression)

Level of The Dependent variable (i)	Independent variable ( $X_{k,i}$ )	Significance Level (Wald Statistic)	Level of The Variable	Parameters ( $\beta_i$ )	Odd Ratio ( $\text{Exp } \beta_i$ )
Mid-Block	Driver Age	0.014	16-25 years old	0.803	2.231
			26-45 years old	1.392	4.022
			46-65 years old	1.806	6.089
			>65 years old	3.429	30.846
	Vehicle 1 Position	0.006	Not related to intersection	3.610	36.978
			Within intersection	-1.468	0.230
	Constant	0.008	Constant	-4.848	0.008

# Contents:

- Research Background
- Data Analysis
- Results
- Discussion of Results
- Conclusion

# Discussion of Results (Two-Vehicle)

✓ **Crash Type:**

**Rear-end** and **side-swipe** collisions are more likely to happen at mid-blocks; while, there is more possibility to have **right angle** and **right turn into oncoming vehicle** collisions at intersections.

✓ **Vehicle 1 and Vehicle 2 Movements:**

According to vehicles movements (“Vehicle 1 Movement” and “Vehicle 2 Movement”) **overtaking from right side** is one of the main causes of mid-block crashes; however, for “Vehicle 1 Movement” **right turning** and for “Vehicle 2 Movement” **moving straight ahead** and **overtaking from left side** are the most possible movements in crashes at intersections.

✓ **Vehicle 1 Visibility Restriction:**

The model parameters show that if the visibility of the driver is not obstructed the possibility of crash is lower at mid-blocks.

✓ **Vehicle 2 Position:**

The related model parameters for “Vehicle 2 Position” confirm higher possibility of crash for **vehicles driving into or out of driveways** at mid-blocks.

# Discussion of Results (Two-Vehicle)

## ✓ Vehicle 2 Action:

Considering “Vehicle 2 Action” the second vehicle is more likely to **proceed normally** or **be stopped** in mid-block crashes. On the other hand, the least number of crashes have been reported when the second vehicle is **going into/out of parking**.

## ✓ Driver 2 Age:

**Drivers aged between 26 and 45** are more likely to be involved in mid-block crashes; while, the possibility of being involved in intersection crashes is more for **older (>65) and younger (16-25) drivers**.

## ✓ Road Angle:

Mid-block crashes are more likely to happen at **straight road sections** and **slight curves**. On the other hand, **presence of severe curve** increases the possibility of crashes at intersections.

# Discussion of Results (One-Vehicle)

## ✓ Traffic Control Code:

Mid-block crashes are more likely to happen on **marked pedestrian crossings** and **uncontrolled roads**. This result shows that the possibility of vehicle to pedestrian crashes for mid-blocks is more than intersections. Furthermore, controlled traffic condition reduces the possibility of mid-block crashes.

## ✓ Lighting Condition:

Results of this model show that the possibility of crash for streets with **poor or no lighting** is significantly more than the possibility of crash in **daylight condition**.

## ✓ Driver Age:

**The possibility of one-vehicle crash at mid-blocks increases as the age of the driver increases.** This result shows that the effect of age is different for one-vehicle and two-vehicle crashes. In two-vehicle crashes the results of binary logistic regression model shows that drivers **aged between 26 and 45** are more likely to be involved in mid-block crashes; while, the possibility of being involved in intersection crashes is more for older (>65) and younger (16-25) drivers.

# Contents:

- Research Background
- Data Analysis
- Results
- Discussion of Results
- Conclusion

# Conclusion

- ✓ This study outlined the understanding of factors affecting one-vehicle and two-vehicle crashes occurred at intersections and non intersection in Australian Capital Territory
- ✓ Data analysis has been conducted using Pearson chi-square test as well as Binary Logistic Regression Model.
- ✓ Final results revealed that different parameters affect intersection and mid-block crashes in different ways.
- ✓ Number of vehicles involved in the crash plays an important role in understanding the factors affecting intersection and mid-block crashes

# Acknowledgements

- NRMA-ACT Road Safety Trust
- Roads, ACT
- Professor Richard Tay, A/Professor Clare D'Souza and Professor William Young

# Questions

[sbahrolloom@students.latrobe.edu.au](mailto:sbahrolloom@students.latrobe.edu.au)