The Role of Connected Vehicle Data for Enhancing Road Safety

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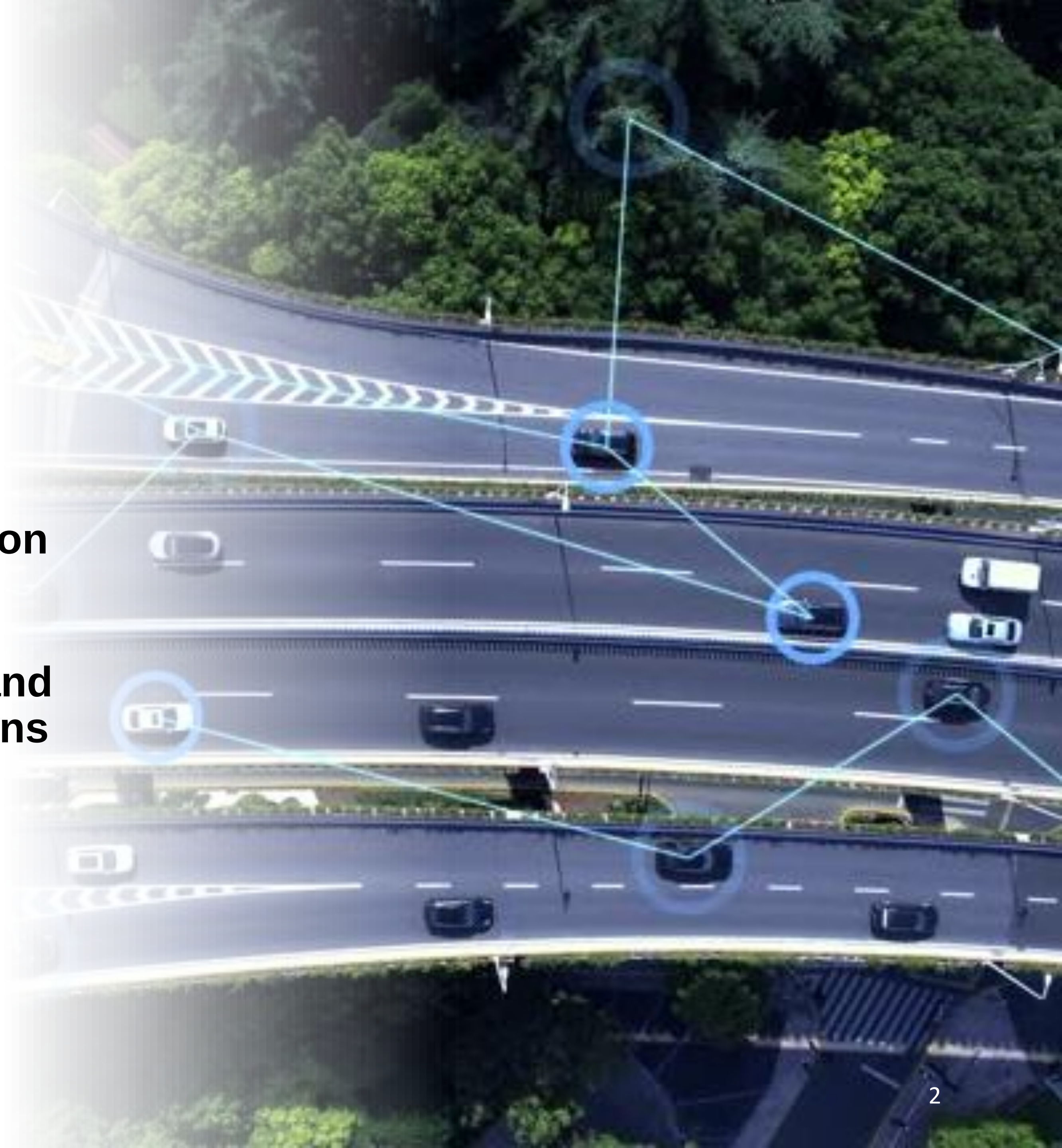
February 2025

SoRSA Road Safety Workshop

Agenda

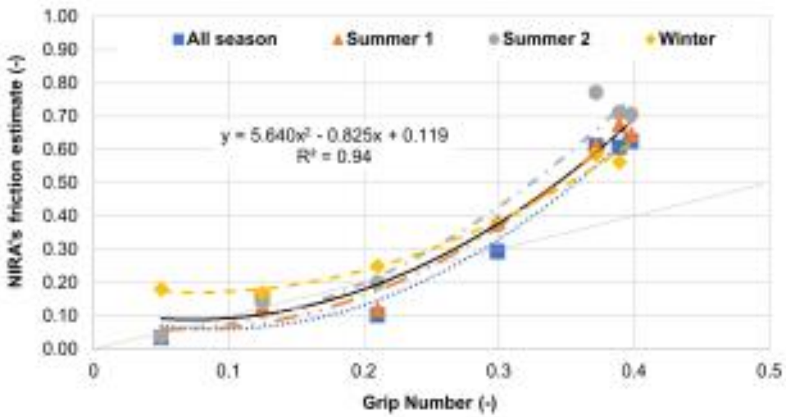
- **About Us**
- **Introduction**
- **Data Collection**
- **Case Study**
- **Challenges and Considerations**
- **Summary**



About Dr Tony Parry

- TRL Ltd (1992 - 2005)
  - Skid resistance measurement and standards
- Uni of Nottingham (2005 - 2022)
  - Collisions and vehicle data
- AtkinsRéalis (2022 -)
  - Vehicle data and pavement engineering

	Investigatory level at 50km/h							
Site category and definition	*0.30*	*0.35*	*0.40*	*0.45*	*0.50*	*0.55*	*0.60*	*0.65*
A Motorway								
B Dual carriageway non-event								
C Single carriageway non-event								
Q Approaches to and across minor and major junctions, approaches to roundabouts								
K Approaches to pedestrian crossings and other high risk situations								
R Roundabout								
G1 Gradient 5-10% longer than 50m								
G2 Gradient >=10% longer than 50m								
S1 Bend radius <500m – dual carriageway								
S2 Bend radius <500m – single carriageway								



About Dr Jwan Kamla

- Where I came from originally - Shaqlawa / Kurdistan

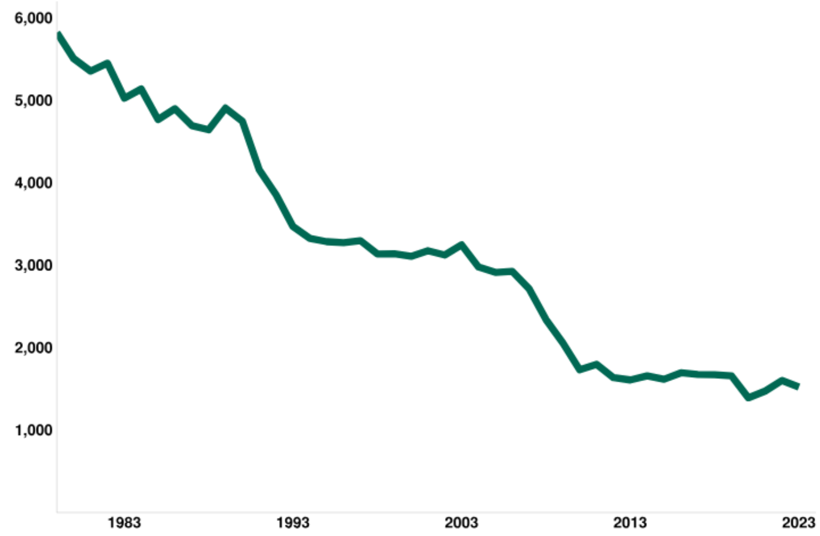
My current home town- Nottingham

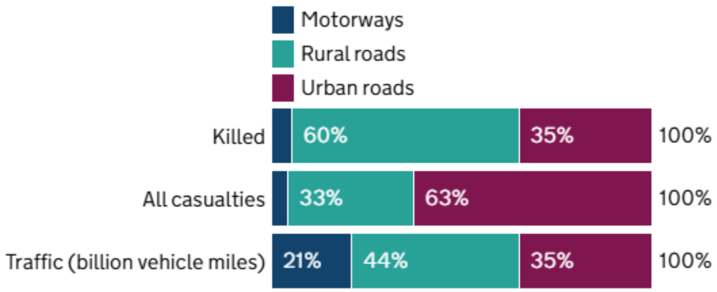
- PhD Civil Engineering (Road safety)- 2016
- MSc Civil Engineering (Traffic and Transportation Engineering) - 2010
- BSc Civil Engineering - 2004
- University of Salahaddin (2005-2011)
- University of Nottingham (2011-2016)
- AECOM (2017-2019) – Strategic Consulting
- Atkins (2019-2022) – Ops Safety
- Jacobs (2022-) – Ops Safety
- CIHT East Midland’s Chair
- SoRSA Web Officer
- CIHT Mentor and Reviewer
- Transportation Research Board Reviewer

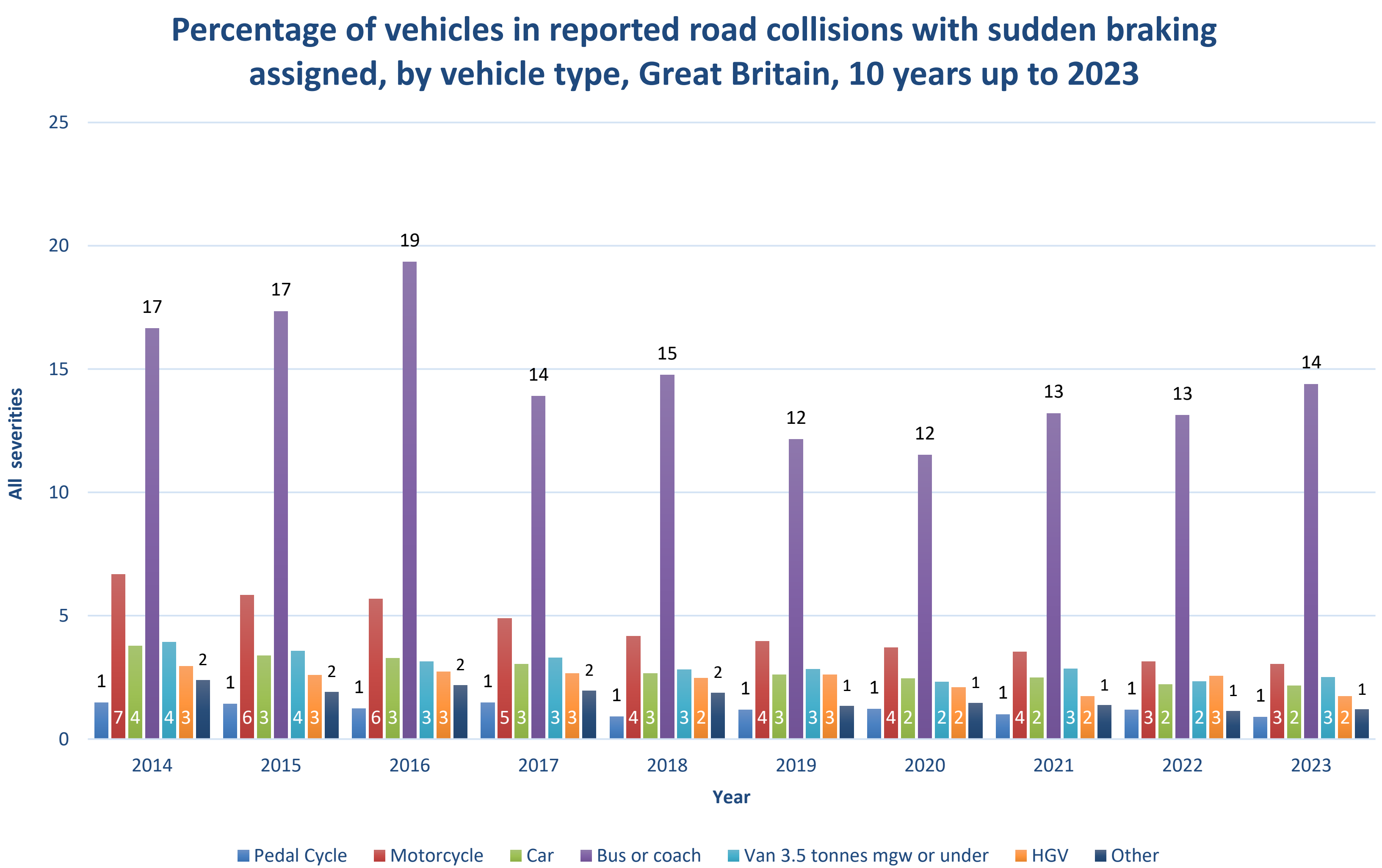
Statistics and current trends

Source: [DfT]

Chart 1: Reported road fatalities in Great Britain, 1979 to 2023





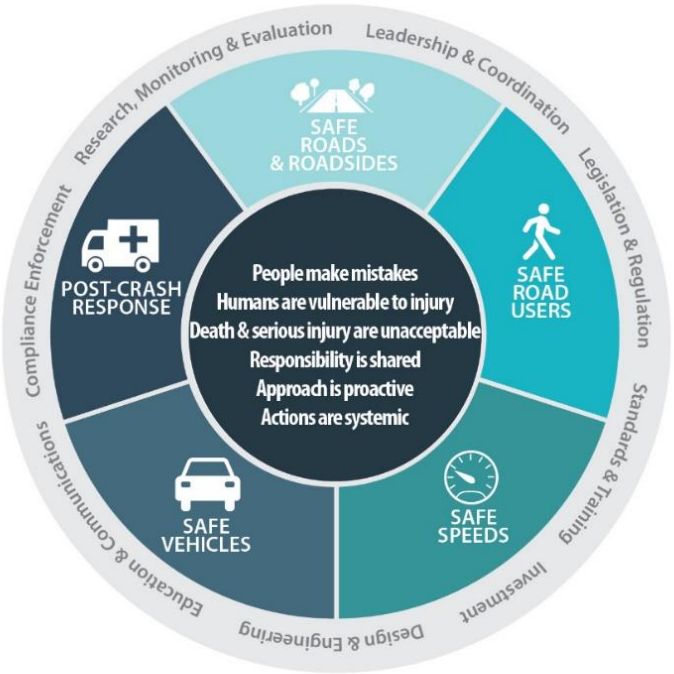


Percentage of vehicles in reported road collisions with sudden braking assigned, by vehicle type, Great Britain, 10 years up to 2023
All severities
Year
0
5
10
15
20
25
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Pedal Cycle
Motorcycle
Car
Bus or coach
Van 3.5 tonnes mgw or under
HGV
Other

Principles of a Safe System Approach

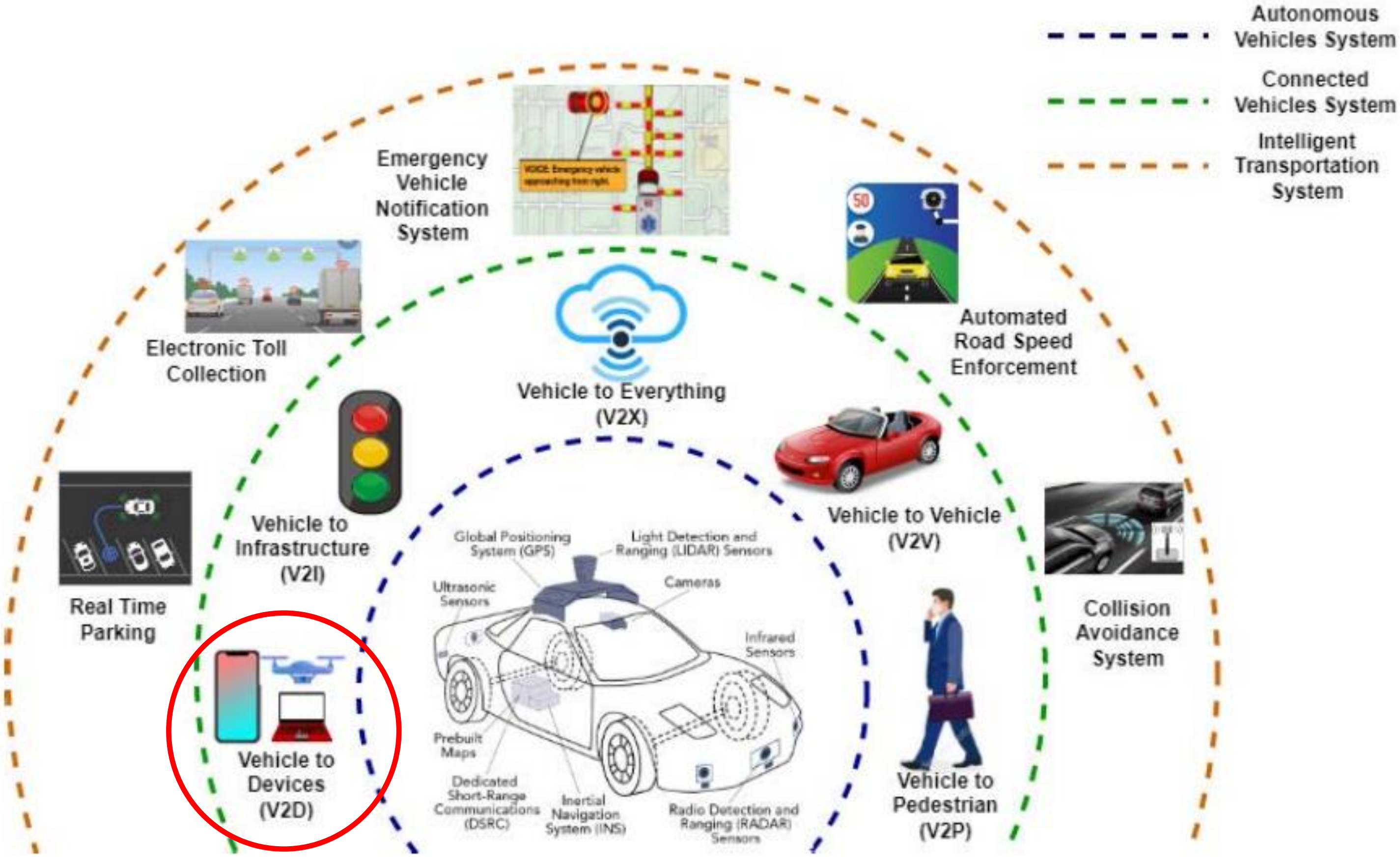
International Transport Forum (ITF) (2016) suggest that the key Safe System principles are that:

- People make mistakes that can lead to road collisions
- The human body has a limited physical ability to tolerate crash forces before harm occurs
- A shared responsibility exists amongst those who design, build, manage and use roads and vehicles and provide post-crash care to prevent crashes resulting in serious injury or death
- All parts of the system must be strengthened to multiply their effects; and if one part fails, road users are still protected.



Source: https://www.pacts.org.uk/safe-system/ and https://www.itf-oecd.org/sites/default/files/docs/safe-system-in-action.pdf

Connected Vehicle Data

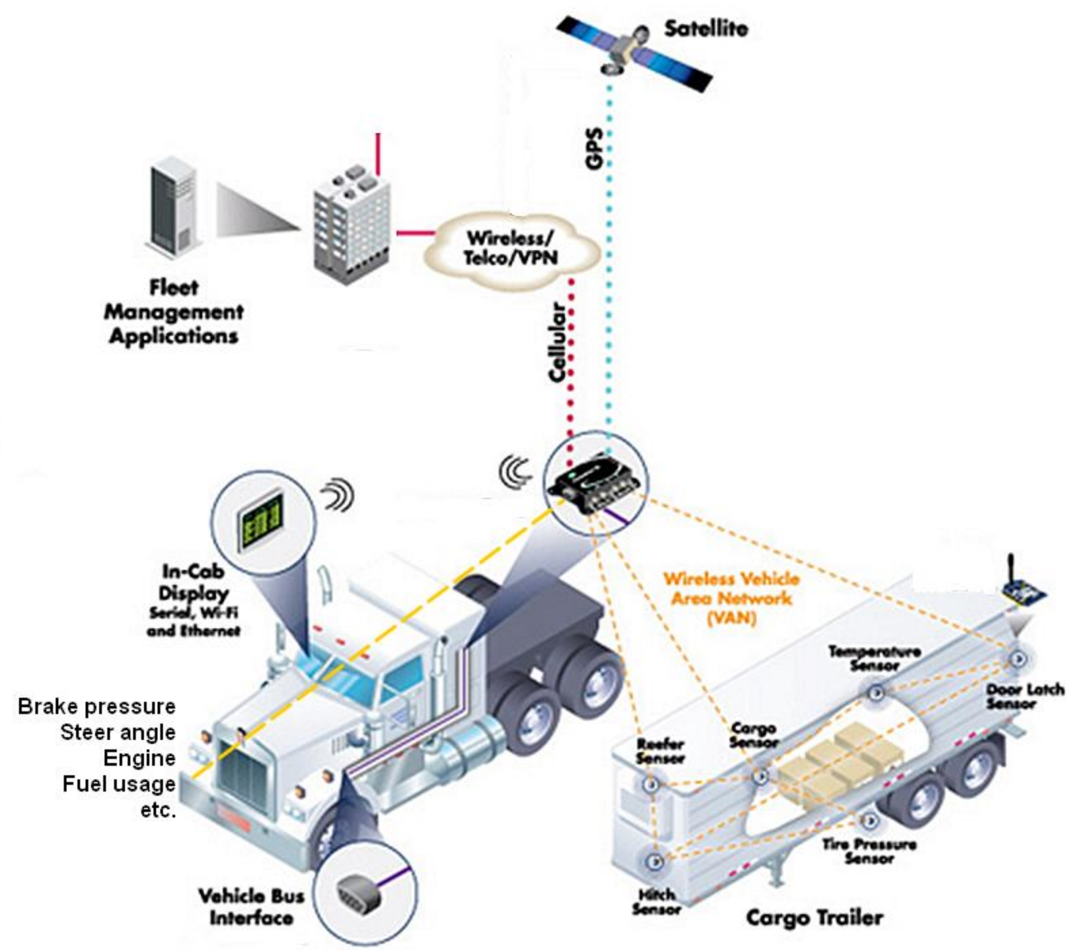


Overview of connected automated system vehicle infrastructure.

Source: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9916257

Proactive Approach-Vehicle to Device data

- Modern vehicle CAN bus collects and can transmit multiple sensor data via cell-phone network to fleet managers
- Highway authorities can now buy products based on these data
- How robust is the evidence that they reflect collision rates?



Data Collection and Utilisation in Modern Truck Fleets

Modern trucks have sophisticated data collection systems

Fleet managers collect data and position of vehicles

Used for:

- Logistical reasons (e.g. delivery timing)
- Monitoring truck condition
- Monitoring driver behaviour

Case Study
PhD Research

Feasibility of using Truck Harsh Braking Incidents (HBIs) to identify locations of high collision risk

Logic & Aims

- Predicting future collision locations as a function of geometric and traffic variables needs analysis of past collision records.
- Can HBIs be used as a surrogate for collisions?
- If so, the findings may be useful for the identification of locations with high collision risk without waiting for a collision history to develop.

AIMS:

- To relate the number of truck HBIs to a range of possible explanatory (geometric and traffic) variables.
- To identify the relationship between total collisions and HBIs alongside traffic and geometric variables.
- To explore whether an analysis of truck HBIs can contribute to the prediction of collisions for all vehicles.

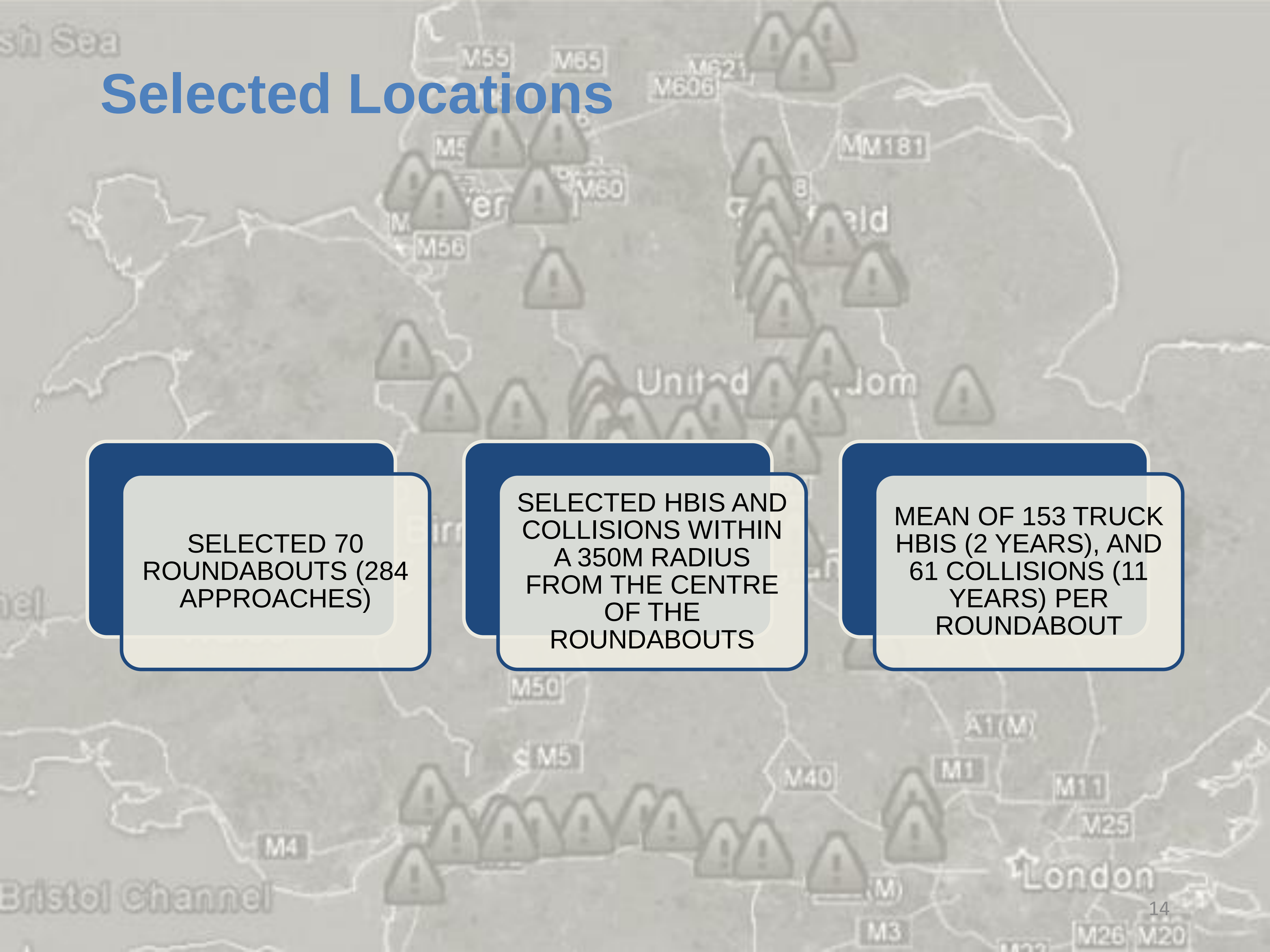
What is a truck Harsh Braking Incident?

- A sudden, excessive, reduction in truck speed
    - – likely caused by bad forward-planning for the situation ahead (e.g. roundabout, traffic lights changing, junctions etc.)

- Defined as >8 km/h/s (heavy truck) and >16 km/h/s (van or light truck), (2.22 and 4.44 m/s^2, respectively)

- If this deceleration extends over a specified duration, it is flagged and the GPS location is recorded.

Selected Locations



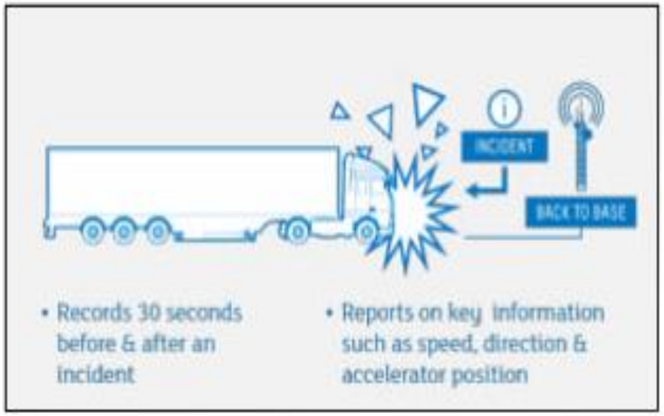
SELECTED 70 ROUNDABOUTS (284 APPROACHES)

SELECTED HBIS AND COLLISIONS WITHIN A 350M RADIUS FROM THE CENTRE OF THE ROUNDABOUTS

MEAN OF 153 TRUCK HBIS (2 YEARS), AND 61 COLLISIONS (11 YEARS) PER ROUNDABOUT

HBI Data

- 8,000 trucks monitored in the UK – 2 years = 2011 & 2012
  - 93% of trucks monitored are 18-20 tonne gross
- 195,297 HBIs
- Derived from the axle speed value (via CAN bus)
  - also from (GPS) where data not available on CAN bus



Recording Incidents and Sending Back to Base (Microlise, 2016)

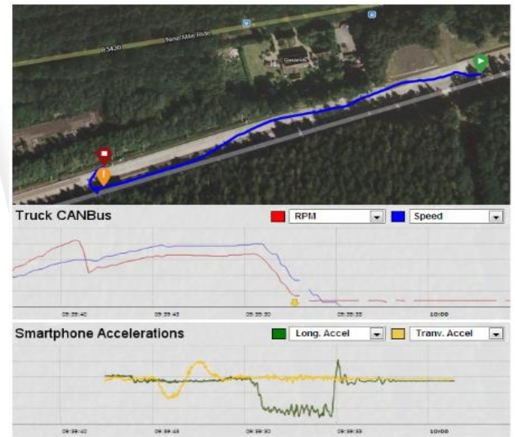
Validation of Harsh Braking Incident – Literature Review

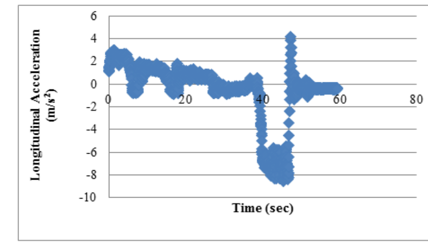
- Longitudinal deceleration varies 0.2 g (1.96 m/s^2) to 0.86 g (8.44 m/s^2)

Olson et al., 2009; Fazeen et al., 2012; Benmimoun et al., 2011;
Bayan et al., 2009; Dingus et al., 2006;
Fitch et al., 2009;Greibe, 2007; Blanco et al. 2011
Grygier et al., 2007; Haque et al., 2016;
Harbluk et al., 2007; Inman et al., 2006;
Lee et al.,2007;Simons-Morton et al., 2009; GeotabInc., 2015; OGP, 2014)

Validation of Harsh Braking Incident – Track Test Trial

- Test truck undertaken in Transport Research Laboratory (TRL)
    - Using smartphone accelerometers
    - Gentle and quick-straight moving maneuvers with gentle and harsh braking at speeds of 40, 50 and 56mph

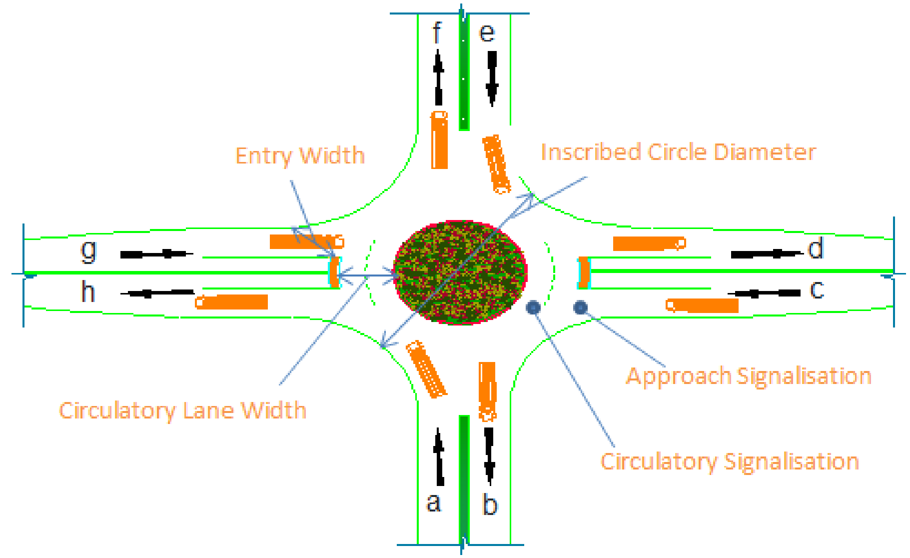




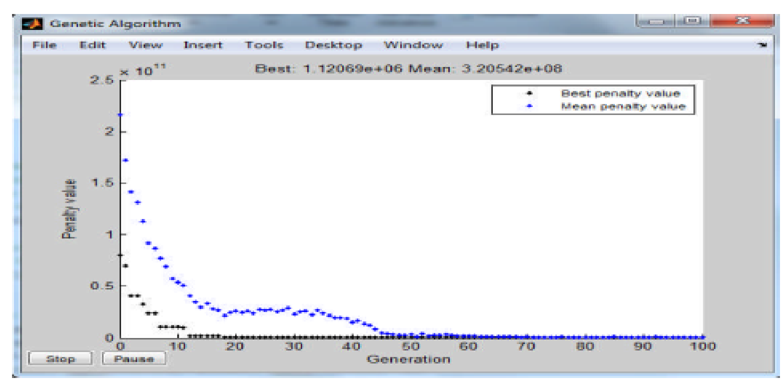
Manoeuvre Type	Max longitudinal deceleration (m/s²)
Straight quick(ish) acceleration, lane change, and harsh braking (speed 40mph)	8.60
Straight quick(ish) acceleration, lane change, and harsh braking (speed 50mph)	8.55
Straight quick(ish) acceleration, lane change, and harsh braking (speed 56mph)	8.51

Traffic & Geometric Data

- **UK Department for Transport**
  - Average annual daily traffic (AADT) & % trucks
  - MATLAB coding and programming (Entry Traffic)
- **Aerial photographs & online mapping**
  - Validated through distance equation and on-site measurement then compared statistically using t-statistic



Geometric Elements of Studied Roundabouts



A sample Result from the Genetic Algorithm

Collision Data

- STATS19 data (UK collision statistics)
- Over 11 years (2002-2012)
- Goods Vehicle were ≤3.5, 3.5-7.5, and ≥7.5 tonne gross

- 5520 total collisions
- 7808 total casualties
  - 84 deaths
  - 692 serious injuries

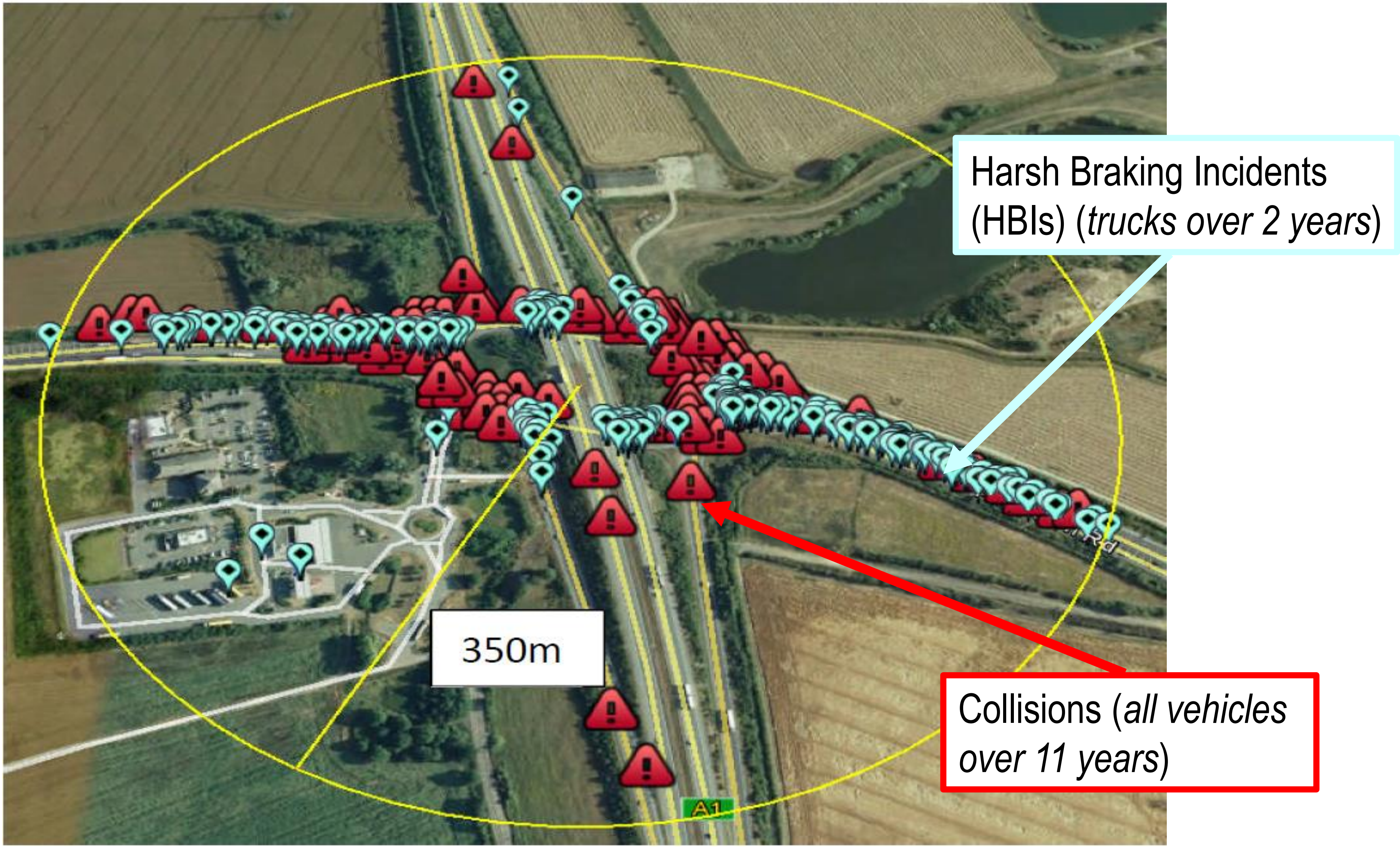
- 1468 involved goods vehicle
- 2050 total casualties
  - 43 deaths
  - 173 serious injuries

Immediate comparisons

- 87% of HBIs occurred at approaches
- 13% of HBIs within circulatory lanes.

- 67% of total collisions at approaches
- 33% of collisions within the circulatory lanes.

Clustering of HBIs and Collisions



Analysis Undertaken

ANOVA Results for Total and Truck Accidents with AADT Based on Different Roundabout Geometric Factors for Whole Roundabouts

Roundabout category/factor	Total Accident with AADT			Truck Accident with AADT		
	R^2	*p*-value	Sig	R^2	*p*-value	Sig
Three-arm	0.06	0.449	no	0.0006	0.94	no
Four-arm	0.15	0.016	yes	0.18	0.006	yes
Five-arm	0.41	0.025	yes	0.16	0.205	no
Six-arm	0.13	0.419	no	0.07	0.568	no
Two-lane	0.52	0.000	yes	0.43	0.000	yes
Three-lane	0.11	0.062	yes	0.096	0.089	yes
Signalised	0.05	0.344	no	0.05	0.338	no
Un-signalised	0.43	0	yes	0.34	0.001	yes
Partially signalised	0.22	0.027	yes	0.16	0.062	yes
Grade-separated	0.22	0.001	yes	0.17	0.002	yes
At -grade	0.36	0.006	yes	0.27	0.021	yes

- GIS data processing- Grid Inquest, Google Earth, and Excel to KML
- Summary statistics
- Categorical and continuous variable classification
- ANOVA analysis
- Variation inflation factor
- Detailed collision investigation and trends
- Detailed harsh braking incident investigation and trends
- **Then detailed modelling**

Statistical Modelling Method and Results

Whole roundabout	roadway width (m)			roundabouts
	Entry width (m)	Fixed	17.47	HBIs increase with increasing entry width over all roundabouts
	Signalised roundabout	Random	-11.86	52% of the roundabouts with traffic signals have lower HBI numbers
	Un-signalised roundabout	Random	-1.42	51% of the roundabouts that are un-signalised have lower HBI numbers
	AADT	Fixed	1.37%*	As AADT increases, HBI numbers increase
	Truck %	Fixed	11.47%	As the percentage of truck traffic increases, HBI numbers increase
Within circulatory	ICD (m)	Fixed	0.03	As ICD increases, total HBIs increase
	Circulatory roadway width (m)	Fixed	-0.54	Circulatory HBIs decrease with increasing circulatory roadway width
	Two-lane circulatory	Random	-3.75	87% of two-lane circulatory systems have lower HBI numbers
	Un-signalised circulatory	Fixed	-3.1	All circulatory systems that are un-signalised have lower HBI numbers
	Signalised circulatory	Random	-0.17	53% of the signalised circulatory systems have lower HBI numbers
	AADT	Fixed	1.28%*	As AADT increases, HBIs increase within the circulatory lanes
			0.113%	As truck percentage increases, HBIs increase within the circulatory lanes
				96% of the approaches have higher HBI numbers when entry width increases
				...alised approaches have ... numbers
				...proaches have

Method

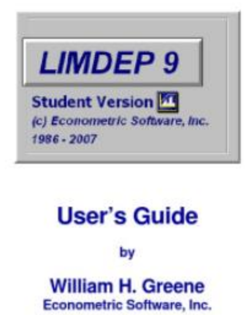
- ✓ Both random- and fixed-parameters approach used to model HBIs and collisions
- ✓ Random parameters used to account for unobserved heterogeneity i.e. independent variables that may change across the road segment or intersections including roundabouts
- ✓ Marginal effects were computed to give the change in the number of collisions given a unit change in any independent variable

```
--> negbin;lhs=Y;rhs=one,x2,x5,x9,x10,x11,x1
    ;rpm;pts=200;halton
    ;fcn=x1(n);marginal effects$

+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Nonrandom parameters
 Constant|   -.75437696      1.37389016     -.549   .5829
 X2      |   -.34701130       .22634492   -1.533   .1252    .17142857
 X5      |    .00359150       .00127928    2.807   .0050  158.285714
 X9      |   -.52912729       .14523375   -3.643   .0003    .40000000
 X10     |    .05828811       .03211237    1.815   .0695   6.97457143
 X11     |    .37379924       .11937370    3.131   .0017  10.6753286
---------+Means for random parameters
 X1      |   -.08766474       .14476267     -.606   .5448    .55714286
---------+Scale parameters for dists. of random parameters
 X1      |    .00776991       .08445208      .092   .9267
---------+Dispersion parameter for NegBin distribution
 ScalParm|   4.37305090      1.02780736     4.255   .0000
```

$$Truck\ accident = 4.1 \times 10^{-3} \times Q^{0.61} \times e^{0.011\ incident}$$

where: Q is the total entry traffic volume.



Developed Models

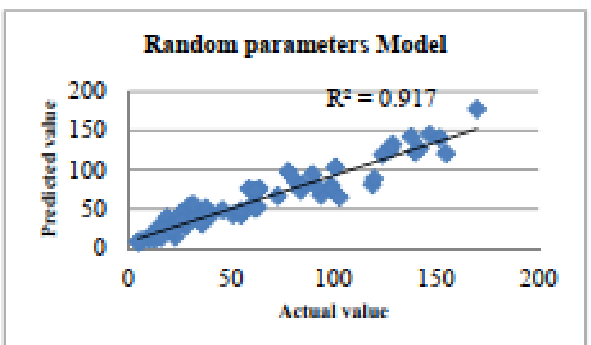
<table>
<tr><th>Dependant variable</th><th>Sections</th><th>Independent variables</th></tr>
<tr><td>All collisions</td><td rowspan="3">- Whole roundabouts
Roundabout Approaches
- Within circulatory lanes
- Grade-separated roundabouts
- At grade roundabout</td><td rowspan="3">AADT, % of HGV, entry width, signalisation (signalised, unsignalised, and partially signalised), circulatory roadway width, type of grade (grade-separated, at grade), number of lanes, number of arms</td></tr>
<tr><td>Collision involving trucks</td></tr>
<tr><td>Harsh braking incidents</td></tr>
<tr><td colspan="3">Additional Modelling including HBI as independent variable</td></tr>
<tr><td>All collisions and for collisions involving goods vehicles</td><td>- Whole roundabouts
Roundabout Approaches
- Within circulatory lanes
- Grade-separated roundabouts
- At - grade roundabout
- For A and B-class
- For M-class approaches
- class approaches</td><td>HBI, AADT, % of HGV, entry width, signalisation (signalised, unsignalised, and partially signalised), circulatory roadway width, type of grade (grade-separated, at grade), number of lanes, number of arms</td></tr>
<tr><td colspan="3">Additional Modelling including HBI as independent variable</td></tr>
<tr><td colspan="3">- For two lane approaches
- For three lane approaches
- For signalised approaches</td></tr>
</table>

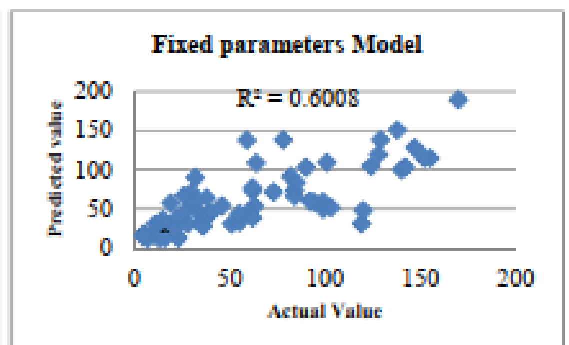
Modelling Results: Collisions

. Total Accident Model Estimation Results

Roundabout Category	Variables	NB Random-parameters model		NB Fixed-parameters model	
		coefficient	*t*-stat	coefficient	*t*-stat
Whole roundabout	**Constant**	-1.45	-1.698*	-1.938	-1.739*
	Geometric characteristics				
	ICD	0.005	6.125***	0.004	3.332***
	Traffic signal (1 if un-signal:0 otherwise)	-0.577	-5.793***	-0.56	-3.790***
	Traffic Characteristics				
	ln(AADT)	0.403	4.951***	0.46	4.843***
	Percentage of average annual daily truck traffic	0.06	4.404***	0.064	1.930*
	SD	0.055	8.664***		
	Dispersion parameter	10.35	4.453***	4.162	4.821***
	Observation numbers	70			
	Log-likelihood with constant only	-348.7167			
	Log-likelihood at convergence	-317.0940[34]		-319.6350	
	Constant	1.087	2.628***	1.408	3.611***
	Log-likelihood at convergence	[illegible]		[illegible]	

* At 90% significance level ** At 95% significance level *** At 99% significance level



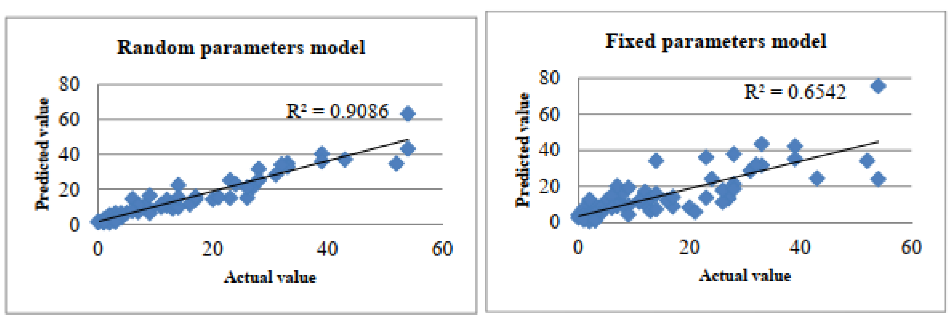


Predicted and Actual Number of Total Accidents for Whole Roundabouts

Modelling Results: Collisions involving trucks

Truck Accident Model Estimation Results

Roundabout Category	Variables	NB Random-parameters model		NB Fixed-parameters model	
		coefficient	*t*-stat	coefficient	*t*-stat
Whole roundabout	**Constant**	-3.82	-2.85***	-4.77	-2.351**
	Geometric characteristics				
	ICD	0.005	4.128***	0.004	2.419**
	Circulatory roadway width	-0.152	-3.871***	-0.0922	-1.510
	Three-arm indicator	-0.45	-1.82*	-0.395	-1.237
	Traffic signal (1 if signalised;0 otherwise)	-0.216	-1.663*	-0.177	-0.819
	SD	0.302	3.431***		
	Traffic signal (1 if un-signalised;0 otherwise)	-0.950	-5.739***	-0.894	-3.932***
	SD	0.438	3.710***		
	Two-lane number indicator	-0.222	-1.731*	-0.044	-0.228
	SD	0.526	6.132***		
	Traffic Characteristics				
	ln(AADT)	0.61	4.992***	0.655	3.526***
	Percentage of average annual daily truck traffic	0.13	7.465***	0.125	3.566***
	Dispersion parameter	13.4	2.456***	3.73	3.393***
	Observation numbers	70			
	Log-likelihood with constant only	-257.6530			
	Log-likelihood at convergence	-216.3584		-218.9279	

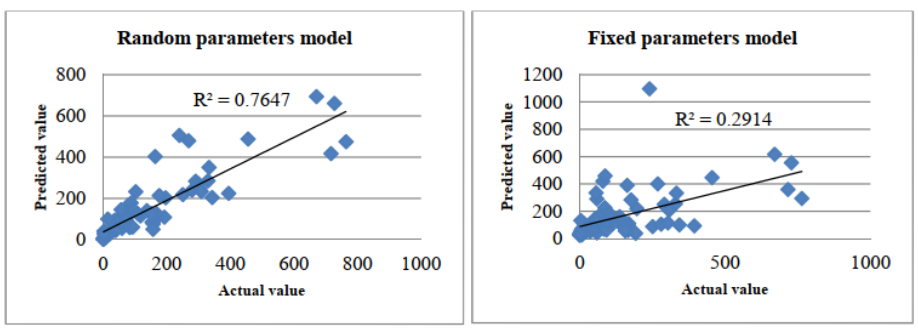


Predicted and Actual Number of Truck Accidents for Whole Roundabouts

Modelling Results: HBIs

HBI Model Estimation Results

Roundabout category	Variables	NB Random-parameters model		NB Fixed-parameters model	
		Coefficient	*t*-stat	coefficient	*t*-stat
Whole roundabout	**Constant**	-11.36	-4.80***	-8.40	-2.351**
	Geometric characteristics				
	Arm number (1 if 3 arm;0 otherwise)	0.064	0.224	0.284	0.662
	SD	*1.117*	*3.982****		
	Circulatory lane width (m)	-0.182	-2.912***	-0.178	-1.569
	Entry width (m)	0.213	2.937***	0.248	2.419**
	Traffic signal (1 if signal;0 otherwise)	-0.145	-0.492	0.215	0.395
	SD	*0.945*	*5.818****		
	Traffic signal (1 if un-signal;0 otherwise)	-0.017	-0.069	0.364	0.895
	SD	*0.842*	*4.574****		
	Traffic Characteristics				
	ln(AADT)	1.37	6.112***	1.08	3.440***
	Percentage of Average annual daily truck traffic	0.14	4.463***	0.110	1.618
	Dispersion parameter	1.81	5.448***	0.917	5.267***
	Observation numbers	70		70	
	Log-likelihood at constant only	-407.4612			
	Log-likelihood at convergence	-396.8231		-401.1357	



Predicted Values and Actual Values of HBIs of Random and Fixed-Parameters NB Models for Whole Roundabouts

Modelling Results: HBIs and Collisions

Effect of an Increase in Geometric and Traffic Variables on Total Accidents, Truck Accidents, and HBIs using Random-Parameters Models.

Roundabout category	Variable	Total accident numbers	Truck accident numbers	HBI numbers
Whole roundabouts	ln(AADT)	↑↑	↑↑	↑↑
	Percentage of average annual daily truck traffic	86% ↑↑	↑↑	↑↑
	Un-signalised roundabouts compared to partially signalised roundabouts	↓↓	↓↓	51% ↓↓
	Signalised roundabouts compared to partially signalised roundabouts	–	76% ↓↓	48% ↓↓
	Two-lane roundabouts compared to three-lane roundabouts	–	66% ↓	–
	ICD	↑	↑	–
	Three-arm roundabouts compared to six-arm roundabouts	–	↓↓	48% ↓↓
	Circulatory roadway width	–	↓↓	↓↓
	Entry width	–	–	↑

The arrows show the increase or decrease in collisions or HBIs due to an increase in the variable and the number of arrows shows the strength of the relationship.

Where a parameter is random, the % of the category influenced in the indicated direction is also given.

Modelling Results: HBIs as independent variable

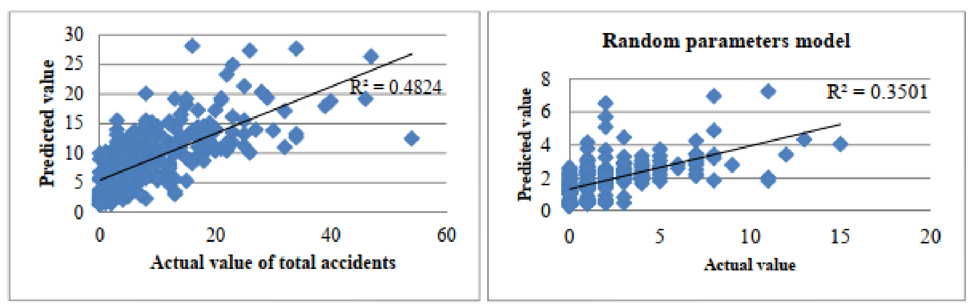
Marginal effects showed that:

- For every 100 HBIs there is an increased number of two collisions.

Random-Parameter Results for Total and Truck Accidents at Approaches

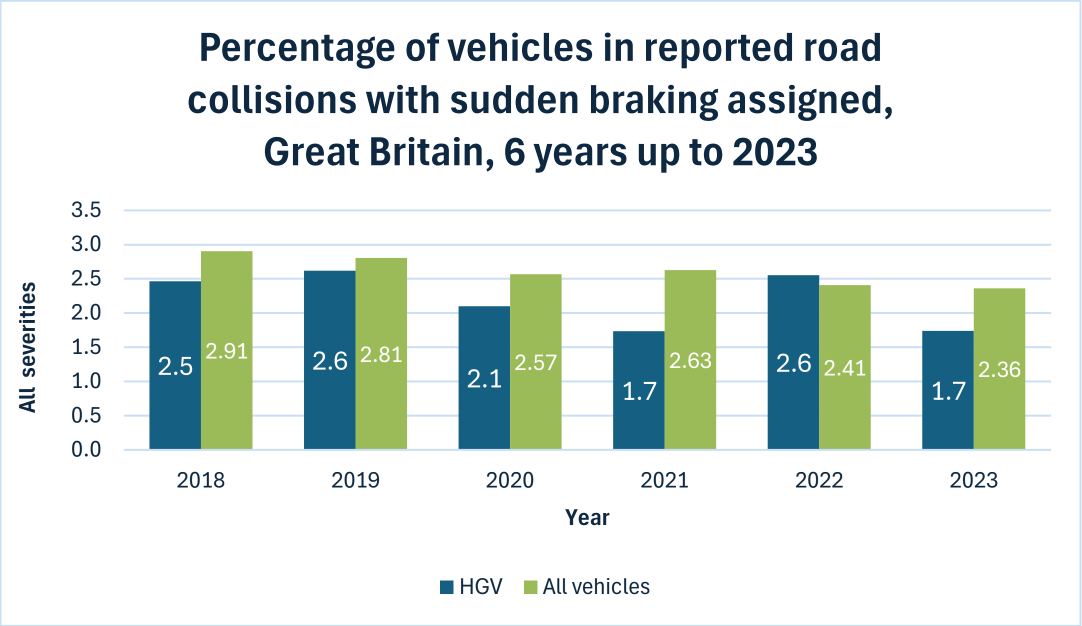
Independent variable	Random parameters NB model for total accidents with geometric, AADT and HBI variables		Random parameters NB model for truck accidents with geometric, and HBI variables	
	Coefficient	*t*-stat	Coefficient	*t*-stat
Constant	-4.45	-4.905***	-1.43	-3.623***
HBI	0.002	1.977**	0.003	2.169**
ln(AADT)	0.59	5.869***		
Signal indicator (1 if signalised; 0 if un-signalised)	0.19	1.988**	0.272	1.858*
Lane number (1 if lane is two; 0 if three)	0.199	1.762*	0.0097	0.063
SD	*0.432*	*7.03***	*0.542*	*5.704****
Entry width	0.013	0.486	0.062	1.976**
SD	*0.007*	*1.67**		
Grade (1 if grade separated; 0 otherwise)	0.77	6.435***	1.23	5.239***
Log-likelihood at convergence	-876.7374		-501.6746	

* At 90% significance level ** At 95% significance level *** At 99% significance level



Predicted Value vs Actual Value of Total Accidents (left) and of Truck Accidents (right) at Approaches

UK Collision Information 2018-2023

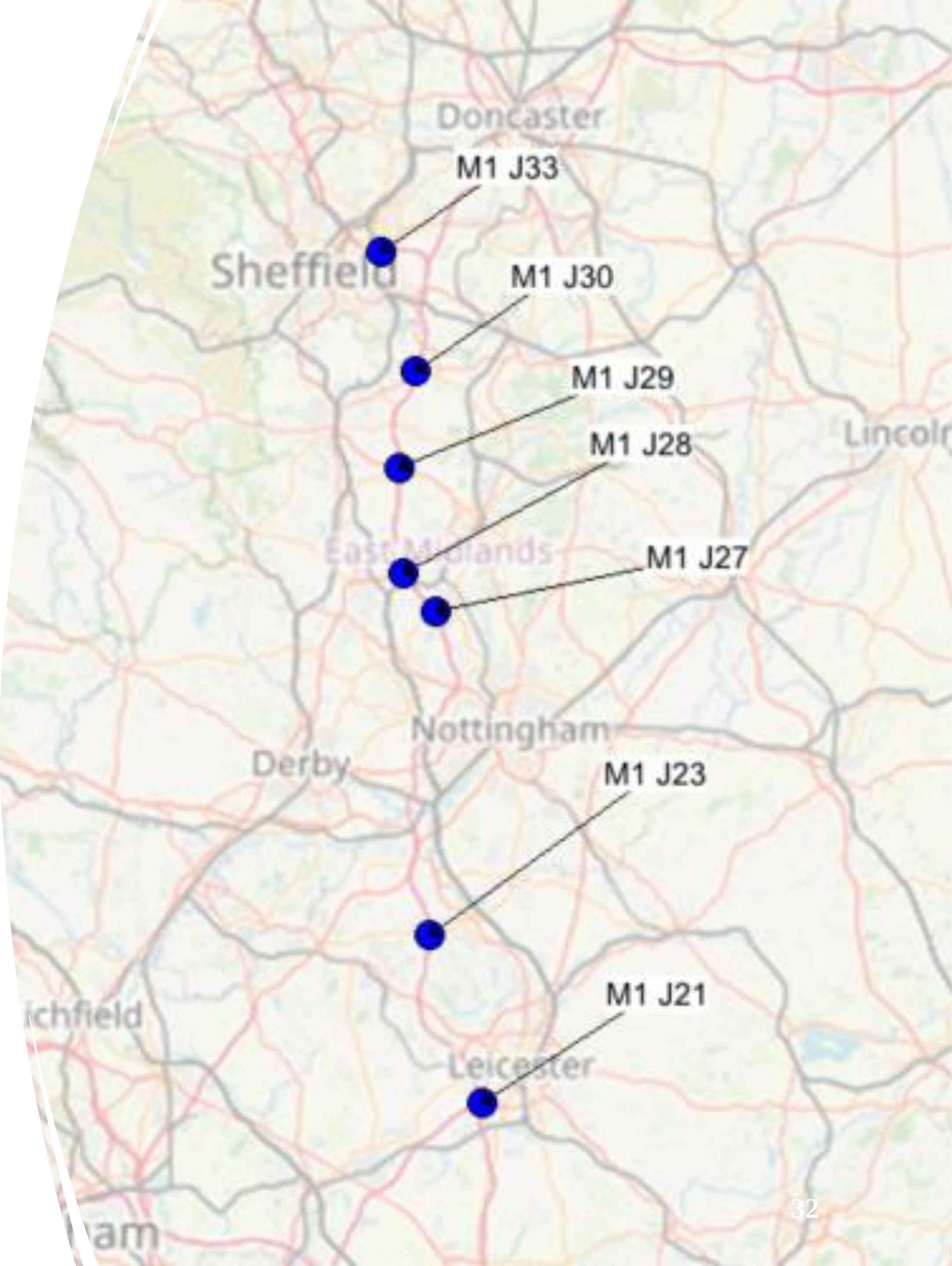


- 642719 collisions
- 1179967 vehicles involved, of these
  - 28701 (2%) are involving HGVs
  - 2 to 3% of all collisions are due to sudden braking
  - 1 to 3% of HGVs involved in collisions are due to sudden braking.

However, it is probably safe to assume that many other collisions caused by the other contributory factors, led to emergency (harsh) braking for instance speed or following too close. This implies that HBIs may indicate collision risks, even if they are not all associated with collisions.

Revisiting Seven Locations: A Comparative Analysis 2018 2023

- Locations:
  - M1 J21, M1 J23, M1 J27, M1 J28, M1 J29, M1 J30 and M1 J33
- 220 collisions within 0.5km
- 458 vehicles involved;
  of these:
  - 30 **(7%)** are involving HGVs. The majority are shunts (70%)



Example Location

- Location with high numbers of collisions- M1 J28
- The M1 J28 2002-2012

Grade-Separated Roundabout (J28 on the M1) with Accident and HBI Positions

J28 on the M1

Total traffic AADT (sum of entry traffic)	106959
Truck %	9.6
Inscribed circle diameter (m)	231
Circulatory roadway width (m)	12.5
Average entry width (m)	12.1
Number of lanes	3
Type of signalisation	Signalised
Type of grade	Grade-separated
Total accident (entry +circulatory lanes)	138
Truck accident (entry +circulatory lanes)	28
Harsh braking incident (entry +circulatory lanes)	728

Collision Information 2018-2023

Collisions within 1km of the junction

- 121 collisions
- High numbers of shunt collisions 41%
- 42% of collisions involved goods vehicles

Collisions within 400m

- 33 collisions
- 45% shunts
- 18% of collisions involved goods vehicles

Other consequences of Harsh Braking

- An indication of reckless driving: close following and speeding.

- Most parts of a vehicle experience stress.

Frequent harsh braking will:

  - Result in frequent overheating of brakes, which typically wears down brake pads and potentially damages brake tubes.
  - Increase the rate of tyre wear, reducing the lifespan of the tyres and their effectiveness in various potentially hazardous situations.
  - Other parts of the vehicle experience more pressure. For example, it will stress the valves and cylinder heads in the engine.

Consequently, this will potentially increase the risk of vehicle breakdowns and the chance of collisions.

Source: https://ubicar.com.au/driving-road-statistics/the-real-impact-of-reckless-braking/

Challenges and Considerations

Challenges:

- Availability of the data - technology is advancing
- Driver behaviour
- Does infrastructure support real time data integration with existing systems?

Considerations:

- Policy and regulations
- Determining liability in the event of an incident where HBI is used as evidence
- Further work considering a fuller range of information from vehicle sensor records, and highway factors including condition, may reveal a more detailed relationship with collisions

Summary

- Collisions are no longer decreasing, indicating the need for additional road safety measures.
- The use of HBIs has proven effective.
  - HBIs are influenced by traffic and geometric variables similarly to total and truck collisions.
  - Truck HBIs are significant predictors of collisions at roundabout approaches. For every 100 HBIs there is an increased number of two collisions.
  - HBIs, in conjunction with traffic and geometric variables, can be valuable in studying collision risks, especially at roundabout approaches.
- An indication of reckless driving: close following and speeding.
- Frequent HBIs have an impact on vehicle tyre and brake pads and hence increased risk of collisions.
- Highway Authorities should consider incorporating HBIs into their road safety strategies.

Publications

- **Jwan Kamla (2016). “Analysing Truck Position Data to Study Roundabout Accident Risk “.** Thesis
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- Kamla J.,Parry T, Dawson A. (2018) **.The Relationship between Truck Harsh Braking Incidents and Truck Accidents at Roundabout Approaches:** Transportation Research Board, 97th Annual Meeting, 10 January 2018, Washington, D.C
- Kamla J.,Parry T, & Dawson A. (2017). **The influence of road marking, shape of central island, and truck apron on total and truck accidents at roundabouts:** Transport Infrastructure and Systems: Transport Infrastructure and Systems, Dell’Acqua & Wegman (Eds), @2017 Taylor and Francis Group, London, ISBN: 978-1-138-03009-1.
- Kamla J.,Parry T, Dawson A. (2017) **.Application of Random Parameters Model to Estimate Truck Accidents at Roundabouts:** Transportation Research Board, 96th Annual Meeting, 11 January 2017, Washington, D.C.
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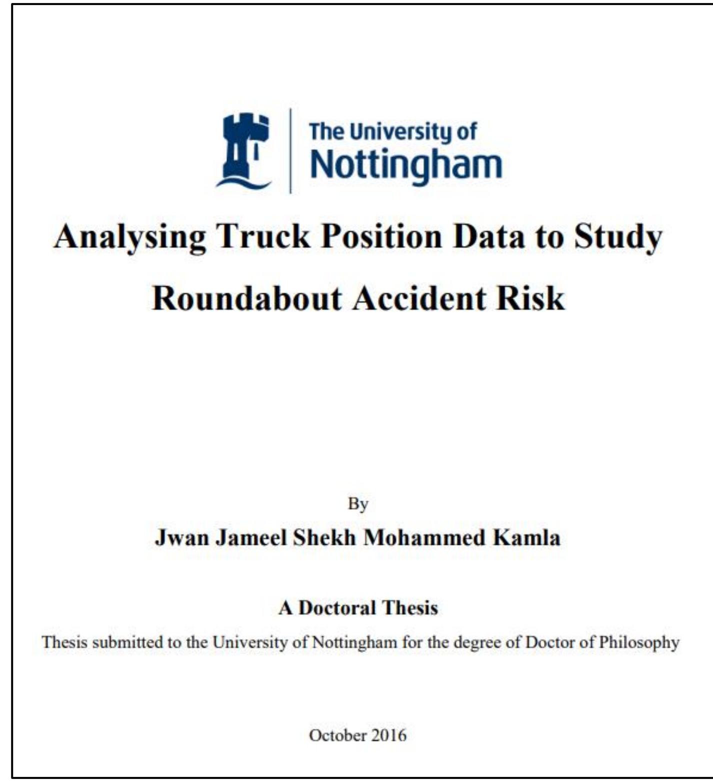
- Kamla J.,Parry T, Dawson A. (2016) . **Roundabout Accident Prediction Model: Random-Parameter Negative Binomial Approach:** Journal of the 604 Transportation Research Board, DOI 10.3141/2585-02, Oct 2016, No. 2585, pp. 11–19.
- Kamla J.,Parry T, Dawson A. (2016) . **Roundabout accident prediction model: an application of random parameters negative binomial approach to roundabout accidents in the United Kingdom:** Transportation Research Board, 95th Annual Meeting, 10-12 January 2016, Washington, D.C.
- Kamla J.,Parry T, Dawson A. (2015) **. Roundabout accident prediction model: an application of random parameters negative binomial approach to roundabout accidents in the United Kingdom:** Transportation Research Board, 94th Annual Meeting, 11-15 January 2015, Washington, D.C.
- Parry T., Kamla J., Dickinson I. (2014). **Feasibility of Using Truck Position Data to Identify Accident Risk.** The 4th International Safer Roads Conference. Cheltenham, UK, 18 - 21 May 2014.
- Kamla J., Parry T. (2014). **Analysing Near-miss Incidents Using Truck Position Data on M1 Motorway Roundabouts:** Kurdistan Student Conference, hosted jointly by the Kurdistan Society and the International Office of Nottingham University, UK, 15 September 2014**.**


The University of Nottingham

Analysing Truck Position Data to Study Roundabout Accident Risk

By

Jwan Jameel Shekh Mohammed Kamla

A Doctoral Thesis

Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

October 2016

Thanks for your attention