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Statistical Modelling of Road Traffic KSI Car Accidents in England (STATS19)

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ABSTRACT: *Several generalised linear models for counts (i.e., Poisson Model) as well as for binary response (i.e., Binary Logistic Model) and ordinal response (i.e., Ordinal Logistic Model) depending on selected multiple explanatory factors (discrete/ categorical) were developed for the road KSI car accidents in England based on STATS19 data (that were manipulated and several new factors were created), after exploratory exploration of discrete/ dichotomous/ nominal/ ordinal factors applied graphical EDA techniques followed by univariate ANOVA/ ANCOVA as well as MANOVA/ MANCOVA based on same selected multiple explanatory factors. Only the main effects as well as two-way interactions were investigated. Majority of main effects and several interaction effects in GLM models were found statistically significant with greater or lesser likelihood of having consequences. The statistically significant KSI car accident factors were identified and quantified for leading to aims to reduce as well as to prevent the car accident, particularly the killed or seriously injured car accidents. It also leads to inform the policymakers on how best to reduce the number and severity of car crashes.*

KEYWORDS : KSI Car Accident, ANOVA/ ANCOVA, Binary Logistic Model, Generalised Linear Modelling, MANOVA/ MANCOVA, Ordinal Logistic Model, Poisson Multiple Model

INTRODUCTION

Road traffic accident is one of the top ten major causes of mortality and morbidity worldwide (WHO, 2010). WHO (2004) reported it as a leading cause of death and injury worldwide. Worldwide over 1.2 million people die per year due to road crashes, the 6th cause of death according to the World Health Organisation (WHO, 2004). Almost 85000 people died from road-traffic injuries in the WHO European Region in 2013 with the rates (9.3 deaths per 100000 population) of road traffic deaths that vary widely in between European countries (Jackisch et al., 2015). About one third of the victims are aged 15-29 years in European Region (Racioppi et al., 2004). This research is to study road KSI car accidents in England based on STATS19 database to identify the major causes of KSI car accidents with the goal of finding ways for their reduction. The aims/ objectives of the research study are as follows:

a) To understand the main and significant factors involved in killed or seriously injured (KSI) car accidents. What are the most significant factors in road traffic KSI car accidents?
b) To develop statistical models to quantify these factors.

c) To map out the possible safety improvement strategies; to inform policymakers on how best to reduce the number and severity of car crashes. How can these KSI car accidents be reduced?

The structure of the study is detailed as **Section 2** is a brief of car accident database construction and data manipulation extracted from STATS19 database. **Section 3** is for exploration of road KSI car accidents by applying graphical EDA techniques. Univariate ANOVA/ ANCOVA followed by MANOVA/ MANCOVA for the number of casualty per KSI car accidents as well as the number of car per KSI accidents depending on several selected discrete/ categorical explanatory factors, is performed in **section 4**. Then, **Section 5** is for Generalised Linear Modelling of counts (e.g., Poisson Multiple Model) followed by binary response (i.e., Binary Logistic Multiple Model) and ordinal response (i.e., Ordinal Logistic Multiple Model) of KSI car accidents depending on multiple explanatory factors as same as previous section. **Section 6** is Research Findings, Discussions, Conclusion and Recommendations based on discrete, nominal, and ordinal factors, are considered, including statements/ explanations of results, unexpected outcome, supports advising cautious interpretation, noting implications, and suggestion for future works.

KSI Car Accident Database Construction and Manipulation

The study is to use the secondary data from DfT-STATS19 database developed by UK Police and Department of Transport, UK. The DfT has undertaken work to link data from STATS19. This combines the details of car accident circumstances (car accident), creating a rich source for research. Data for car accidents in England are to be extracted from the DfT-STATS19 database. This secondary data covers the period from 1979 through 2015.

The first stage in this "Big Data" study is to undertake a detailed analysis of the recorded (official) data (i.e., DfT-STATS19 data) of KSI car accidents in England. The data are to visualise applying 'Exploratory Data Analysis (EDA)' techniques followed by data analysis applying 'Univariate/ Multivariate Analysis of Variance/ Covariance' techniques. This study in the second stage is to develop the generalised linear models for counts as well as for binary response and ordinal response, depending on several selected discrete/ categorical explanatory factors. The range of counts models commonly applied includes Poisson model, and/ or Negative Binomial (NB) model. Poisson Models are to be developed subject to $E[y] = VAR[y]$ *or* $E[y] > VAR[y]$; otherwise, NB models are to be developed subject to $E[y] < VAR[y]$.

Prior to modelling, the road KSI car accidents are to be explored based on their types such that a) discrete factors by Trend line/ Histogram/ Scattergram; b) dichotomous factors by Column Multiple Chart/ tabular format; c) nominal factors by Pareto Bar-Charts; and d) ordinal factors by Bar-Charts following EDA techniques. In statistical analysis, univariate analysis of variance (ANOVA) as well as covariance (ANCOVA) for the selected discrete response variable(s) of road KSI car accidents depending on several discrete/ categorical explanatory factors (controlled by accident year for ANCOVA), including main effects as well as interaction effects, are to be executed. Again, in statistical analysis, multivariate analysis of variance (MANOVA) as well as covariance (MANCOVA) for two+ discrete response variable(s) of

road KSI car accidents depending on several discrete/ categorical explanatory factors (controlled by accident year for MANCOVA), including main effects as well as interaction effects, are to be tested/ executed.

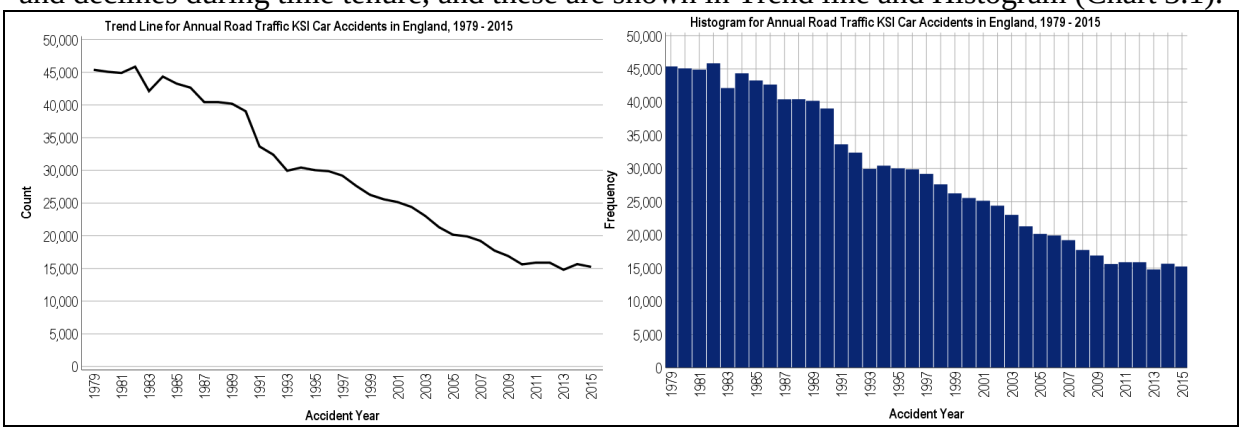
The reported/ recorded data of KSI car accidents extracted from the datasets of DfT-STATS19 under Department for Transport for the period of 1979-2015, had been used for database construction and then, the data in database were manipulated individually using 'data function' and 'transform function' of SPSS 23.0.1 version and onwards. One accident database based on DfT-STATS19 database, was constructed containing the existing factors and the new factors computed from existing factor(s) following the database design such as determining the purpose of the database, finding, and organising the information required, dividing the information items into tables, turning information items into columns, specifying the primary keys, applying the normalisation rules, refining the design, and setting up the table relationship. Total 49 factors/ factors, containing 10 discrete factors as well as 13 dichotomous, 14 nominal and 12 ordinal factors, were included in KSI car accident database shown in Table 2.1.

Table 2.1: KSI cases in Car Accident Database based in Accident Index in England

KSI Cases in Car Accident Database based on Accident Index in England								
#	Factor	Type	Valid Case	Valid Case %	Missing Case	Missing Case %	Other Case	Other Case %
1	Accident Year	Discrete	1089560	100.00	0	0.00	0	0.00
2	First Road Number	Discrete	815907	74.90	273653	25.10	0	0.00
3	Latitude	Discrete	332388	30.51	757172	69.49	0	0.00
4	Longitude	Discrete	332388	30.51	757172	69.49	0	0.00
5	Number of Casualty per KSI Accident	Discrete	1089560	100.00	0	0.00	0	0.00
6	Number of Car per KSI Accident	Discrete	1089560	100.00	0	0.00	0	0.00
7	OSGR Easting	Discrete	1086224	99.69	3336	0.31	0	0.00
8	OSGR Northing	Discrete	1087796	99.84	1764	0.16	0	0.00
9	Second Road Number	Discrete	1069885	98.19	19675	1.81	0	0.00
10	Speed Limit	Discrete	1089560	100.00	0	0.00	74	0.00
11	Built-non-Built-up Speed Area	Dichotomous	1089557	100.00	3	0.00	0	0.00
12	Carriageway Hazards-non-Hazards	Dichotomous	1082347	99.30	7213	0.70	0	0.00
13	First Classified-non-Classified Road Class	Dichotomous	1089560	100.00	0	0.00	0	0.00
14	First Classified Trunk-non-Trunk Road Class	Dichotomous	797819	73.20	291741	26.80	0	0.00
15	First Numbered-non-Numbered Road	Dichotomous	1089505	100.00	55	0.00	0	0.00
16	Junction Control-non-Control	Dichotomous	607766	55.80	481794	44.20	0	0.00
17	Junction-non-Junction Details	Dichotomous	1089471	100.00	89	0.00	0	0.00
18	Pedestrian Crossing at Human Control	Dichotomous	3450	0.30	100	0.00	0	0.00
19	Pedestrian Crossing at Human Control-non-Control	Dichotomous	1069882	98.20	100	0.00	0	0.00
20	Pedestrian Crossing at Physical-non-Physical Facilities	Dichotomous	1069890	98.20	19670	1.80	0	0.00
21	Police Officer's Attandance-non-Attendance at Accident Scene	Dichotomous	321525	29.50	768035	70.50	0	0.00
22	Road Environment Urban-non-Urban	Dichotomous	479862	44.00	609698	56.00	0	0.00
23	Special Conditions-non-Conditions at Site	Dichotomous	1067904	98.00	21656	2.00	0	0.00
24	Carriageway Hazards (5-Level)	Nominal	18983	1.70	7213	0.70	1063364	97.60
25	First Classified Road Class (5-Level)	Nomial	797819	73.20	100	0.00	291741	26.80
26	England Region (9-Level)	Nomial	1089560	100.00	100	0.00	0	0.00
27	Junction Control (4-Level)	Nomial	596831	54.80	481794	44.20	10935	1.00
28	Junction Details (8-Level)	Nomial	597571	54.80	89	0.00	491900	45.10
29	Lights Conditions (5-Level)	Nomial	1089413	100.00	147	0.00	0	0.00
30	Pedestrian Crossing at Physical Facilities (5-Level)	Nomial	134016	12.30	19670	1.80	935874	85.90
31	Police Officer's Attandance at Accident Scene (3-Level)	Nominal	321525	29.50	768035	70.50	0	0.00
32	Road Environment (3-Level)	Nomial	479862	44.00	609698	56.00	0	0.00
33	Road Surface Conditions (7-Level)	Nomial	1088290	99.90	1270	0.10	0	0.00
34	Road Type (5-Level)	Nomial	1070965	98.30	18595	1.70	0	0.00
35	Second Road Class (5-Level)	Nomial	578347	53.10	511213	46.90	0	0.00
36	Special Conditions at Site (7-Level)	Nomial	19691	1.80	21656	2.00	1048213	96.20
37	Weather Conditions (8-Level)	Nomial	1089460	100.00	100	0.00	0	0.00
38	Accident Day (7-Level)	Ordinal	1089560	100.00	100	0.00	0	0.00
39	Accident Month (12-Level)	Ordinal	1089560	100.00	100	0.00	0	0.00
40	Accident Time (12-Level)	Ordinal	1089472	100.00	88	0.00	0	0.00
41	Car per KSI Accident (3-Level)	Ordinal	1089560	100.00	100	0.00	0	0.00
42	Casualty per KSI Car Accident (3-Level)	Ordinal	1089560	100.00	100	0.00	0	0.00
43	First Numbered Road Digit (6-Level)	Ordinal	815907	74.90	55	0.00	273598	25.10
44	First Numbered Road Zone (4-Level)	Ordinal	793467	72.80	22495	2.10	273598	25.10
45	Latitude Band (5-Level)	Ordinal	332384	30.50	757176	69.50	0	0.00
46	Longitude Band (5-Level)	Ordinal	332388	30.50	757172	69.50	0	0.00
47	OSGR Easting Band (5-Level)	Ordinal	1086224	99.70	3336	0.30	0	0.00
48	OSGR Northing Band (7-Level)	Ordinal	1087796	99.80	1764	0.20	0	0.00
49	Speed Limit Zone (6-Level)	Ordinal	1089557	100.00	3	0.00	0	0.00

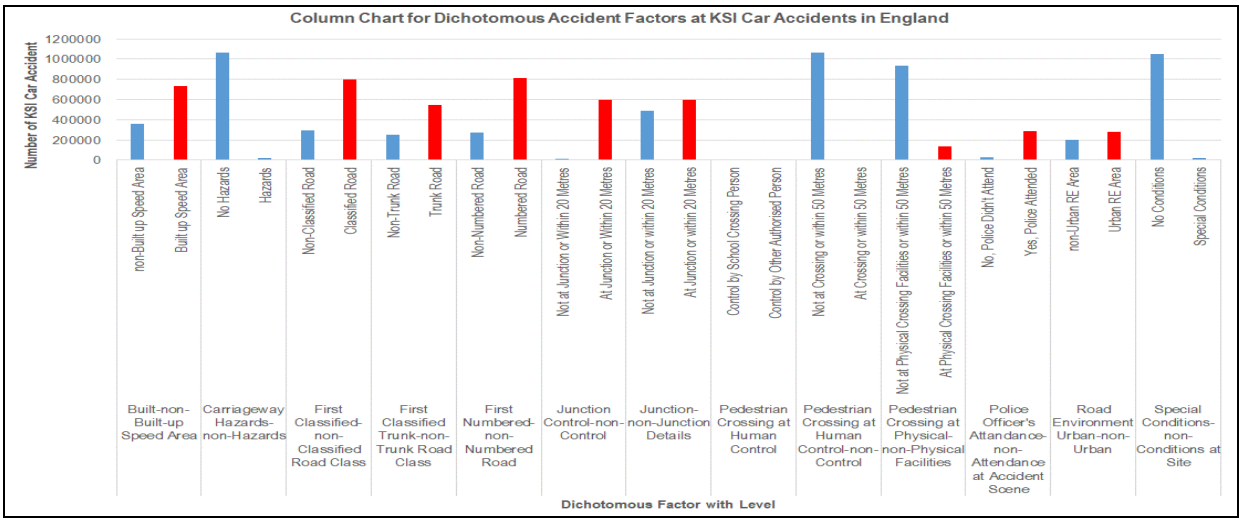
Exploration of KSI Car Accidents and Initial Findings

The KSI car accidents fell steadily from 1979 through 2015, although these have some upturns and declines during time tenure, and these are shown in Trend line and Histogram (Chart 3.1).



Trend/ Histogram 3.1: Annual KSI Car Accidents, 1979 - 2015

Thirteen dichotomous accident factors in KSI car accidents are shown in column multiple charts 3.2 as well as tabular format in table 3.2.



Column Multiple Charts 3.2: Dichotomous Factors in KSI Car Accidents

Built-up speed area (67.4%) had about twice of non-built-up speed area (32.6%) KSI car accident. First numbered roads' KSI accidents (74.9%) were three times higher than first non-numbered roads (25.1%). Non-hazards carriageway had 98.2% KSI accident, only 1.8% in hazards carriageway. There were more than double KSI accident in first classified road class (73.2%) to first non-classified road class (26.8%). Junction KSI accident (54.8%) was greater than non-junction KS accident (45.2%), while controlled junction had 98.2% of KSI accident and 1.8% in non-controlled junction. Human non-controlled pedestrian crossing (99.7%) had dominant accidents, but about zero (0.3%) accidents were in human controlled pedestrian crossing (0.4%), where controlled by school crossing person (71.3%) accident was about twice of "controlled by other authorised person (28.7%)". Physical facility in pedestrian crossing (12.5%) had lower accidents than non-physical facility (87.5%). Police officer's attendance at

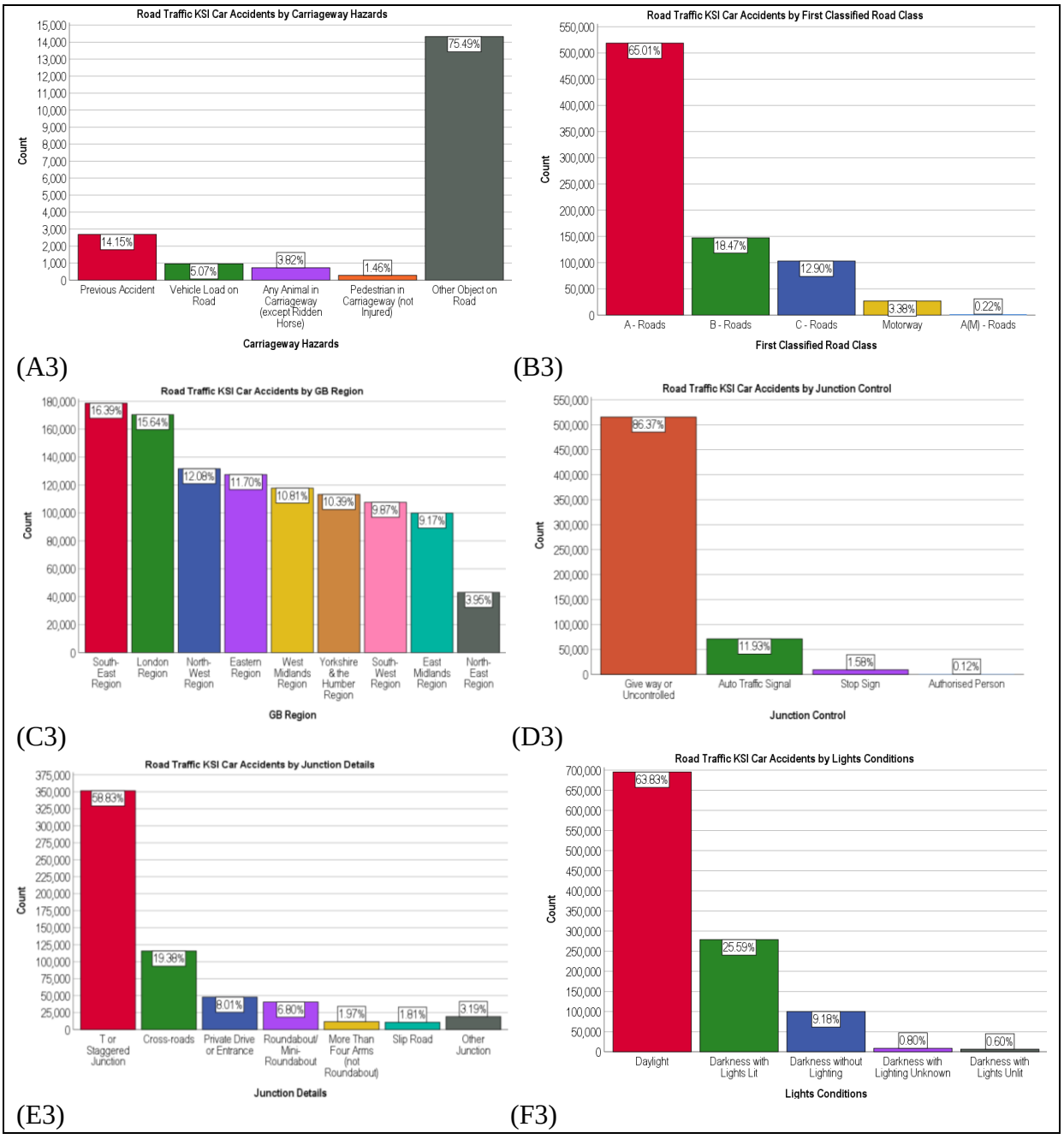
accident scene was 90.3%, but absent was 9.7%. No special condition at road site (98.2%) had leading accident, but only 1.8% in special condition at site. 58.3% of KSI accidents were in urban road environment and 41.7% was in rural road environment.

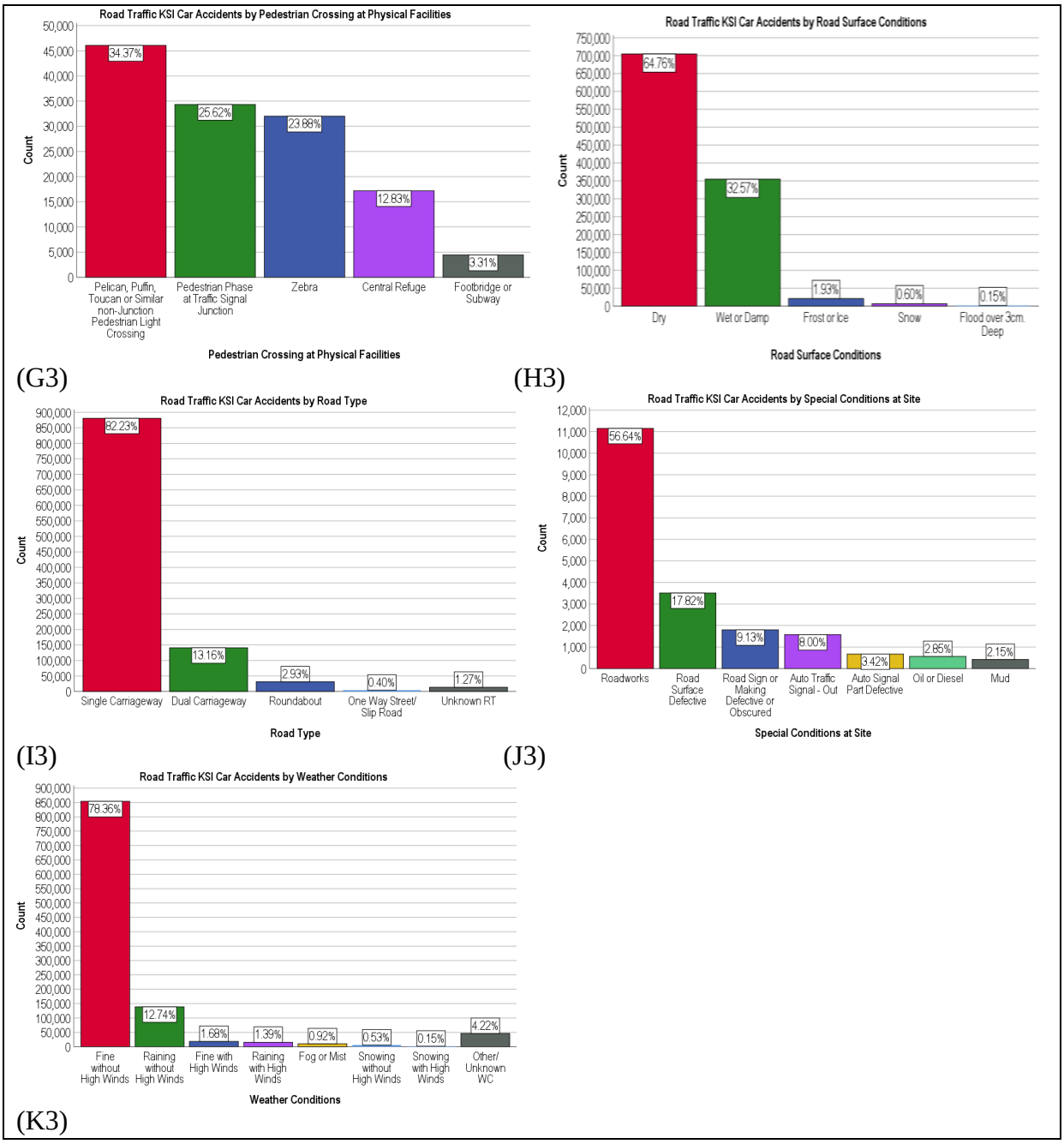
Table 3.2: Dichotomous Factors in KSI Car Accidents

Dichotomous Accident Factors at Road Traffic KSI Car Accidents in England				
#	Dichotomous Factor	Dichotomous Level	Frequency	Percent
1	Built-non-Built-up Speed Area	non-Built up Speed Area	355603	32.6
		Built up Speed Area	733954	67.4
2	Carriageway Hazards-non-Hazards	No Hazards	1063364	98.2
		Hazards	18983	1.8
3	First Classified-non-Classified Road Class	Non-Classified Road	291741	26.8
		Classified Road	797819	73.2
4	First Classified Trunk-non-Trunk Road Class	Non-Trunk Road	250330	31.4
		Trunk Road	547489	68.6
5	First Numbered-non-Numbered Road	Non-Numbered	273598	25.1
		Numbered	815907	74.9
6	Junction Control-non-Control	Not at Junction or Within 20 Metres	10935	1.8
		At Junction or Within 20 Metres	596831	98.2
7	Junction-non-Junction Details	Not at Junction or within 20 Metres	491900	45.2
		At Junction or within 20 Metres	597571	54.8
8	Pedestrian Crossing at Human Control	Control by School Crossing Person	2461	71.3
		Control by Other Authorised Person	989	28.7
9	Pedestrian Crossing at Human Control-non-Control	Not at Crossing or within 50 Metres	1066432	99.7
		At Crossing or within 50 Metres	3450	0.3
10	Pedestrian Crossing at Physical-non-Physical Facilities	Not at Physical Crossing Facilities or within 50 Metres	935874	87.5
		At Physical Crossing Facilities or within 50 Metres	134016	12.5
11	Police Officer's Attandance-non-Attendance at Accident Scene	No, Police Didn't Attend	31274	9.7
		Yes, Police Attended	290251	90.3
12	Road Environment Urban-non-Urban	non-Urban RE Area	199911	41.7
		Urban RE Area	279951	58.3
13	Special Conditions-non-Conditions at Site	No Conditions	1048213	98.2
		Special Conditions	19691	1.8

Eleven nominal accident factors in road KSI car accidents are shown in bar charts 3.3 (Bars: A3 – K3). 'Previous accident carriageway hazards' (11%) had the highest KSI car accidents followed by 'vehicle load on road' (5%) (Bar-A3). Bar-B3 indicates that first classified class A-roads (65%) had the highest KSI accidents followed by B-roads (18%) and C-roads (13%). The highest KSI car accidents occurred in South-East Region (16.39%) followed by London (15.64%), and North-West (12.08%) (Bar-C3). Bar-D3 indicates that junction control of give-way/ uncontrolled (86.37%) had the highest KSI accidents followed by auto-traffic-signal (11.93%) and stop-sign (1.58%). T/ Staggered junctions (58.83%) had the highest KSI accidents followed by cross-roads (19.39%), and private-drive-or-entrance (9.01%) (Bar-E3). Maximum KSI accidents occurred during daylight (63.83%) followed by darkness-lights-lit (25.59%) and darkness-no-lighting (9.18%) (Bar-F3). Again, in the physical facilities of pedestrian crossing, pelican-puffin-taucan-or-similar-non-junction-pedestrian-light-crossing (34.37%) had the highest KSI accidents followed by pedestrian-phase-at-traffic-signal-junction (25.62%) and zebra crossing (23.88%) (Bar-G3).

The highest KSI car accidents occurred on 'dry roads' surface (54.76%) followed by wet/ damp (3257%) and frost/ ice (1.93%) (Bar-H3). 'Single-carriageway' (82.23%) of road type had the highest and majority KSI car accidents followed by dual-carriageways (13.16%) and roundabouts (2.93%) (Bar-I3). Bar-J4 indicates that 'road-works' (56.64%) of 'special condition at site' had the highest accidents followed by 'road surface defective' (17.82%), and 'road sign/ making defective/ closured' (9.13%). The majority of KSI accidents occurred during 'fine weather without high winds' (78.36%) followed by 'raining without high winds' (12.74%) and 'fine with high winds' (1.68%) (Bar-K3).


Road Traffic KSI Car Accidents by Carriageway Hazards
Count
14.15%
5.07%
3.82%
1.46%
75.49%
Previous Accident
Vehicle Load on Road
Any Animal in Carriageway (except Ridden Horse)
Pedestrian in Carriageway (not Injured)
Other Object on Road
Carriageway Hazards
(A3)
Road Traffic KSI Car Accidents by First Classified Road Class
Count
65.01%
18.47%
12.90%
3.38%
0.22%
A - Roads
B - Roads
C - Roads
Motorway
A(M) - Roads
First Classified Road Class
(B3)
Road Traffic KSI Car Accidents by GB Region
Count
16.39%
15.64%
12.08%
11.70%
10.81%
10.39%
9.87%
9.17%
3.95%
South-East Region
London Region
North-West Region
Eastern Region
West Midlands Region
Yorkshire & the Humber Region
South-West Region
East Midlands Region
North-East Region
GB Region
(C3)
Road Traffic KSI Car Accidents by Junction Control
Count
86.37%
11.93%
1.58%
0.12%
Give way or Uncontrolled
Auto Traffic Signal
Stop Sign
Authorised Person
Junction Control
(D3)
Road Traffic KSI Car Accidents by Junction Details
Count
58.83%
19.38%
8.01%
6.80%
1.97%
1.81%
3.19%
T or Staggered Junction
Cross-roads
Private Drive or Entrance
Roundabout/ Mini-Roundabout
More Than Four Arms (not Roundabout)
Slip Road
Other Junction
Junction Details
(E3)
Road Traffic KSI Car Accidents by Lights Conditions
Count
63.83%
25.59%
9.18%
0.80%
0.60%
Daylight
Darkness with Lights Lit
Darkness without Lighting
Darkness with Lighting Unknown
Darkness with Lights Unlit
Lights Conditions
(F3)

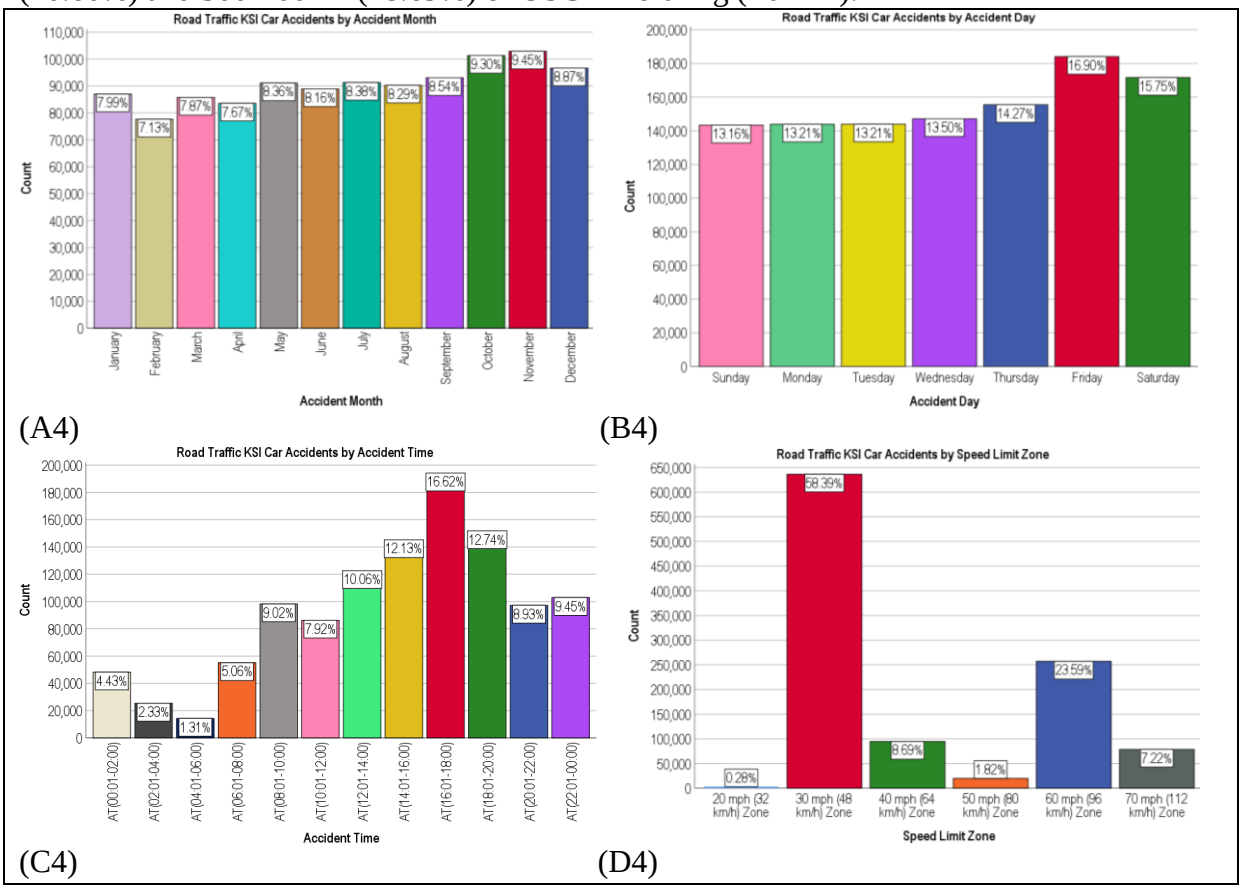


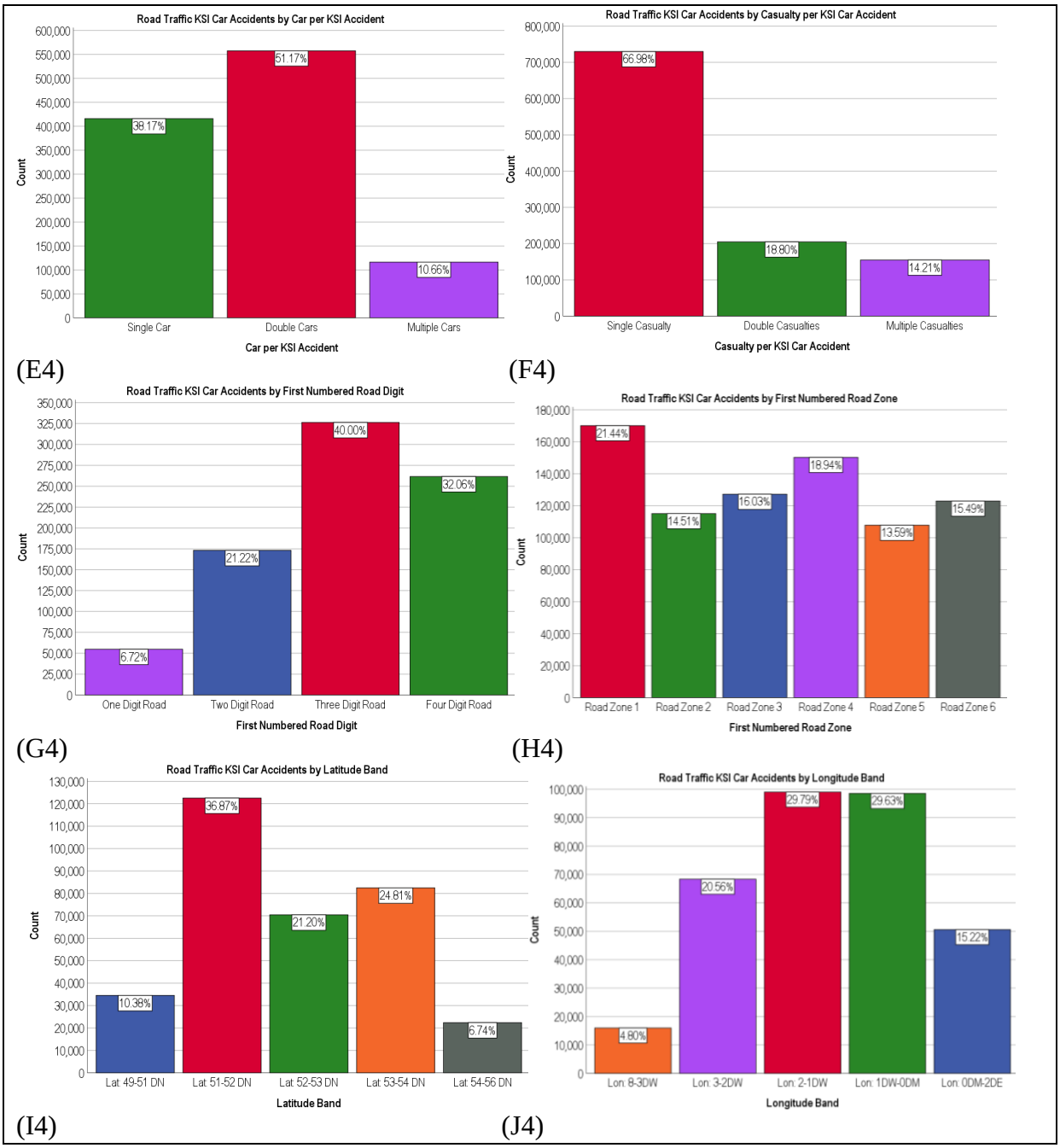
Bar Charts 3.3: Nominal Factors in KSI Car Accidents

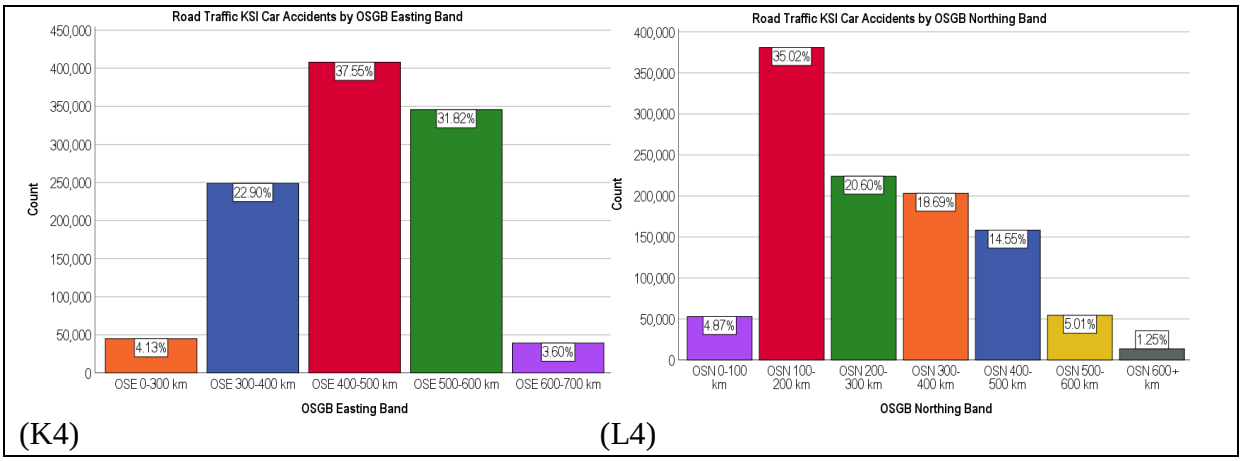
Twelve ordinal accident factors in road KSI car accidents are shown in bar-charts 3.4 (Bars: A4 – L4). The KSI car accidents were the highest in November (9.45%) followed by October (9.30%) and December (8.87%) (Bar-A4). Friday (16.90%) had the highest followed by Saturday (15.75%) and Thursday (14.27%) (Bar-B4). The highest KSI accidents were in 16:00-18:00 (16.62%) followed by 18:00-20:00 (12.74%) and 14:00-16:00 (12.13%) (Bar-C4). The KSI accidents in the speed limit zone of 30 miles-per-hour (58.39%) had the highest followed by 60 mph (23.59%) and 40 mph (8.69%) (Bar-D4). Double cars per KSI accident (51.17%)

are the highest followed by single car (38.17%) and multiple cars (10.66%) (Bar-E4). On the other hand, single casualty per KSI car accident (66.98%) was the highest followed by double casualties (18.80%) and multiple casualties (14.21%) (Bar-F4). First numbered three-digit roads (40%) had highest KSI car accidents followed by four-digit (32.06%) and two-digit (21.22%) (Bar-G4). First numbered zone-1 roads (21.44%) had the highest KSI accidents followed by zone-4 (18.94%), and zone-3 (16.03%) (Bar-H4).

The highest KSI car accidents occurred in 51^0N-52^0N (36.87%) followed by 53^0N-54^0N (24.81%) and 52^0N-53^0N (21.20%) of latitude (Bar-I4), while the highest KSI accidents occurred in 2^0W-1^0W (29.79%) followed by 1^0W-0^0M (29.63%) and 3^0W-2^0W (20.56%) of longitude (Bar-J4). On the other hand, the highest KSI accidents occurred in 400-500km (37.55%) followed by 500-600km (31.82%) and 300-400km (22.90%) of OSGR easting (Bar-K), while the highest KSI accidents occurred in 100-200km (35.02%) followed by 200-300km (20.60%) and 300-400km (18.69%) of OSGR Northing (Bar-L4).




Road Traffic KSI Car Accidents by Car per KSI Accident
Count
38.17%
51.17%
10.66%
Single Car
Double Cars
Multiple Cars
Car per KSI Accident
(E4)
Road Traffic KSI Car Accidents by Casualty per KSI Car Accident
Count
66.98%
18.80%
14.21%
Single Casualty
Double Casualties
Multiple Casualties
Casualty per KSI Car Accident
(F4)
Road Traffic KSI Car Accidents by First Numbered Road Digit
Count
6.72%
21.22%
40.00%
32.06%
One Digit Road
Two Digit Road
Three Digit Road
Four Digit Road
First Numbered Road Digit
(G4)
Road Traffic KSI Car Accidents by First Numbered Road Zone
Count
21.44%
14.51%
16.03%
18.94%
13.59%
15.49%
Road Zone 1
Road Zone 2
Road Zone 3
Road Zone 4
Road Zone 5
Road Zone 6
First Numbered Road Zone
(H4)
Road Traffic KSI Car Accidents by Latitude Band
Count
10.38%
36.87%
21.20%
24.81%
6.74%
Lat: 49-51 DN
Lat: 51-52 DN
Lat: 52-53 DN
Lat: 53-54 DN
Lat: 54-56 DN
Latitude Band
(I4)
Road Traffic KSI Car Accidents by Longitude Band
Count
4.80%
20.56%
29.79%
29.63%
15.22%
Lon: 8-3DW
Lon: 3-2DW
Lon: 2-1DW
Lon: 1DW-0DM
Lon: 0DM-2DE
Longitude Band
(J4)



(K4) (L4)

Bar Charts 3.4: Ordinal Factors in KSI Car Accidents

ANOVA and MANOVA of KSI Car Accidents and Initial Findings

Univariate analysis of variance (ANOVA) as well as analysis of covariance (ANCOVA) followed by multivariate analysis of variance (MANOVA) as well as multivariate of covariance (MANCOVA) for the casualty per KSI car accident and the car per KSI accident depending on five nominal explanatory factors such as England region, lights conditions, road surface conditions, road type, and weather conditions; and eight ordinal explanatory factors such as accident month, accident day, accident time, casualty per car accident, car per KSI accident, OSGR easting band, OSGR northing band, and speed limit zone; including main effects and two-way interaction effects (nominal-by-nominal and ordinal-by-ordinal), were executed.

ANOVA/ ANCOVA for the Casualty per KSI Car Accident

ANOVA for the 'casualty per KSI car accident' depending on thirteen categorical explanatory factors with common sample size, $n = 1066286$; including main effects and two-way interaction effects, were performed by fulfilling the assumptions. The output is displayed in Table 4.1a. Out of five nominal main effects, only road type had statistically significant mean differences ($F_{(4,\ 1065005)} = 7.471,\ p < 0.001;\ \eta^2_{(P)} < 0.001$). In two-way interactions of nominal-by-nominal factors, only five pairs (i.e., England region × lights conditions; England region × weather conditions; lights conditions × weather conditions; road surface conditions × weather conditions; and road type × weather conditions) out of 10 unique pairs had significant ($p \leq 0.05$) mean differences statistically. All the ordinal main effects, except OSGR easting band, were statistically significant ($p \leq 0.05$) mean differences. In two-way interactions, only six pairs (i.e., accident day × OSGR easting band; accident month × accident time; accident month × OSGR easting band; accident time × OSGR easting band; accident time × OSGR northing band; OSGR northing band × speed limit zone) out of 28 unique pairs of ordinal-by-ordinal factors, were not statistically significant ($p > 0.05$), remaining 22 pairs had significant interactions ($p \leq 0.05$).

Table 4.1a: Analysis of Variance (ANOVA) for the Casualty per KSI Car Accident

ANOVA Tests of Between-Subjects Effects for the Number of Casualty per KSI Car Accident							
	Source	**Type III SS**	**df**	**Mean Square**	**F**	**p-Value**	**Partial Eta²**
	Corrected Model*	1089540.730	1281	850.539	2543.840	<0.001	0.754
	Intercept	1786.994	1	1786.994	5344.640	<0.001	0.005
Main Effects	England Region	2.809	8	0.351	1.050	0.395	<0.001
	Lights Conditions	1.049	4	0.262	0.784	0.535	<0.001
	Road Surface Conditions	1.042	4	0.260	0.779	0.539	<0.001
	Road Type	9.991	4	2.498	7.471	<0.001	<0.001
	Weather Conditions	2.703	7	0.386	1.155	0.325	<0.001
	Accident Month	22.217	11	2.020	6.041	<0.001	<0.001
	Accident Day	92.852	6	15.475	46.284	<0.001	<0.001
	Accident Time	24.524	11	2.229	6.668	<0.001	<0.001
	Casualty per Car Accident	35121.103	2	17560.552	52521.066	<0.001	0.090
	Car per Accident	162.360	2	81.180	242.798	<0.001	<0.001
	OSGR Easting Band	1.980	4	0.495	1.480	0.205	<0.001
	OSGR Northing Band	4.611	6	0.768	2.298	0.032	<0.001
	Speed Limit Zone	150.866	5	30.173	90.244	<0.001	<0.001
Interaction Effects	England Region x Lights Conditions	19.994	32	0.625	1.869	0.002	<0.001
	England Region x Road Surface Conditions	11.070	32	0.346	1.035	0.413	<0.001
	England Region x Road Type	7.687	32	0.240	0.718	0.879	<0.001
	England Region x Weather Conditions	53.437	56	0.954	2.854	<0.001	<0.001
	Lights Conditions x Road Surface Conditions	4.831	16	0.302	0.903	0.565	<0.001
	Lights Conditions x Road Type	6.432	16	0.402	1.202	0.257	<0.001
	Lights Conditions x Weather Conditions	28.093	28	1.003	3.001	<0.001	<0.001
	Road Surface Condition x Road Type	4.377	16	0.274	0.818	0.666	<0.001
	Road Surface Conditions x Weather Conditions	20.533	28	0.733	2.193	<0.001	<0.001
	Road Type x Weather Conditions	308.202	28	11.007	32.921	<0.001	0.001
	Accident Month x Accident Day	37.735	66	0.572	1.710	<0.001	<0.001
	Accident Day x Accident Time	68.580	66	1.039	3.108	<0.001	<0.001
	Accident Day x Car per Accident	56.564	12	4.714	14.098	<0.001	<0.001
	Accident Day x Casualty per Car Accident	1194.836	12	99.570	297.798	<0.001	0.003
	Accident Day x OSGR Easting Band	5.294	24	0.221	0.660	0.894	<0.001
	Accident Day x OSGR Northing Band	17.535	36	0.487	1.457	0.038	<0.001
	Accident Day x Speed Limit Zone	24.701	30	0.823	2.463	<0.001	<0.001
	Accident Month x Accident Time	46.628	121	0.385	1.153	0.120	<0.001
	Accident Month x Car per Accident	16.581	22	0.754	2.254	0.001	<0.001
	Accident Month x Casualty per Car Accident	256.069	22	11.639	34.812	<0.001	0.001
	Accident Month x OSGR Easting Band	13.627	44	0.310	0.926	0.611	<0.001
	Accident Month x OSGR Northing Band	28.974	66	0.439	1.313	0.045	<0.001
	Accident Month x Speed Limit Zone	26.251	55	0.477	1.428	0.020	<0.001
	Accident Time x Car per Accident	32.492	22	1.477	4.417	<0.001	<0.001
	Accident Time x Casualty per Car Accident	612.014	22	27.819	83.202	<0.001	0.002
	Accident Time x OSGR Easting Band	16.629	44	0.378	1.130	0.256	<0.001
	Accident Time x OSGR Northing Band	24.136	66	0.366	1.094	0.281	<0.001
	Accident Time x SpeedLimitZone6	43.032	55	0.782	2.340	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	3519.299	4	879.825	2631.428	<0.001	0.010
	Car per Accident x OSGR Easting Band	5.649	8	0.706	2.112	0.031	<0.001
	Car per Accident x OSGR Northing Band	19.171	12	1.598	4.778	<0.001	<0.001
	Car per Accident x Speed Limit Zone	290.602	10	29.060	86.915	<0.001	0.001
	Casualty per Car Accident x OSGR Easting Ba	55.023	8	6.878	20.571	<0.001	<0.001
	Casualty per Car Accident x OSGR Northing Ba	121.394	12	10.116	30.256	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	900.013	10	90.001	269.181	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	12.573	24	0.524	1.567	0.038	<0.001
	OSGR Easting Band x Speed Limit Zone	15.456	20	0.773	2.311	0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	13.693	30	0.456	1.365	0.088	<0.001
	Error	356087.125	1065005	0.334			
	Total	4178017.000	1066287				
	Corrected Total	1445627.86	1066286				
	*R^2 = 0.754 (Adjusted R^2 = 0.753)						
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)						

Again, ANCOVA for the 'casualty per KSI car accident' depending on thirteen categorical explanatory factors controlled by accident year (covariate) with common sample size, $n = 1066286$; including main effects and two-way interaction effects, were performed by fulfilling the assumptions. The output is displayed in Table 4.1b. Out of five nominal main effects, only road type had statistically significant adjusted mean differences ($F_{(4,\ 1065004)} = 7.551,\ p < 0.001;\ \eta^2_{(P)} < 0.001$). In two-way interactions of nominal-by-nominal factors, only five pairs out of 10 unique pairs had significant ($p \leq 0.05$) adjusted mean differences statistically (i.e., England region × road surface conditions; England region × road type; lights conditions × road surface conditions; lights conditions × road type; and road type × road surface conditions).

All the ordinal main effects, except OSGR easting band, had statistically significant ($p \leq 0.05$) adjusted mean differences. In two-way interactions of ordinal-by-ordinal factors, only six pairs (i.e., accident day × OSGR easting band; accident month × accident time; accident month × OSGR easting band; accident time × OSGR easting band; accident time × OSGR northing band; OSGR northing band × speed limit zone) out of 28 unique pairs, had not statistically significant ($p > 0.05$) adjusted mean differences, remaining 22 pairs had significant interactions ($p \leq 0.05$) in adjusted mean differences. The controlled variable, accident year was also statistically significant ($F_{(1,\ 1065004)} = 6.025,\ p = 0.014;\ \eta^2_{(P)} < 0.001$).

Table 4.1b: ANCOVA for Number of Casualty per KSI Car Accident Controlled by Accident Year

ANCOVA Tests of Between-Subjects Effects for the Number of Casualty per Car KSI Accident Controlled by Accident Year							
	Source	**Type III SS**	**df**	**Mean Square**	**F**	**p-Value**	**Partial Eta²**
	Corrected Model*	1089542.745	1282	849.877	2541.872	<0.001	0.754
	Intercept	156.408	1	156.408	467.796	<0.001	<0.001
Main Effects	England Region	2.791	8	0.349	1.043	0.400	<0.001
	Lights Conditions	1.021	4	0.255	0.764	0.549	<0.001
	Road Surface Conditions	1.038	4	0.259	0.776	0.541	<0.001
	Road Type	10.098	4	2.525	7.551	<0.001	<0.001
	Weather Conditions	2.704	7	0.386	1.155	0.325	<0.001
	Accident Month	22.166	11	2.015	6.027	<0.001	<0.001
	Accident Day	92.778	6	15.463	46.248	<0.001	<0.001
	Accident Time	24.278	11	2.207	6.601	<0.001	<0.001
	Casualty per Car Accident	35119.656	2	17559.828	52519.150	<0.001	0.090
	Car per Accident	162.669	2	81.334	243.261	<0.001	<0.001
	OSGR Easting Band	1.979	4	0.495	1.480	0.205	<0.001
	OSGR Northing Band	4.549	6	0.758	2.268	0.034	<0.001
	Speed Limit Zone	150.279	5	30.056	89.893	<0.001	<0.001
Interaction Effects	England Region x Lights Conditions	19.988	32	0.625	1.868	0.002	<0.001
	England Region x Road Surface Conditions	11.059	32	0.346	1.034	0.414	<0.001
	England Region x Road Type	7.691	32	0.240	0.719	0.878	<0.001
	England Region x Weather Conditions	53.464	56	0.955	2.855	<0.001	<0.001
	Lights Conditions x Road Surface Conditions	4.827	16	0.302	0.902	0.566	<0.001
	Lights Conditions x Road Type	6.420	16	0.401	1.200	0.258	<0.001
	Lights Conditions x Weather Conditions	28.008	28	1.000	2.992	<0.001	<0.001
	Road Surface Condition x Road Type	4.412	16	0.276	0.825	0.658	<0.001
	Road Surface Conditions x Weather Conditions	20.532	28	0.733	2.193	<0.001	<0.001
	Road Type x Weather Conditions	308.151	28	11.005	32.916	<0.001	0.001
	Accident Month x Accident Day	37.692	66	0.571	1.708	<0.001	<0.001
	Accident Day x Accident Time	68.570	66	1.039	3.107	<0.001	<0.001
	Accident Day x Car per Accident	56.565	12	4.714	14.098	<0.001	<0.001
	Accident Day x Casualty per Car Accident	1193.618	12	99.468	297.496	<0.001	0.003
	Accident Day x OSGR Easting Band	5.288	24	0.220	0.659	0.895	<0.001
	Accident Day x OSGR Northing Band	17.527	36	0.487	1.456	0.038	<0.001
	Accident Day x Speed Limit Zone	24.743	30	0.825	2.467	<0.001	<0.001
	Accident Month x Accident Time	46.694	121	0.386	1.154	0.118	<0.001
	Accident Month x Car per Accident	16.564	22	0.753	2.252	0.001	<0.001
	Accident Month x Casualty per Car Accident	255.756	22	11.625	34.770	<0.001	0.001
	Accident Month x OSGR Easting Band	13.616	44	0.309	0.926	0.613	<0.001
	Accident Month x OSGR Northing Band	28.996	66	0.439	1.314	0.045	<0.001
	Accident Month x Speed Limit Zone	26.258	55	0.477	1.428	0.020	<0.001
	Accident Time x Car per Accident	32.388	22	1.472	4.403	<0.001	<0.001
	Accident Time x Casualty per Car Accident	611.766	22	27.808	83.169	<0.001	0.002
	Accident Time x OSGR Easting Band	16.621	44	0.378	1.130	0.256	<0.001
	Accident Time x OSGR Northing Band	24.139	66	0.366	1.094	0.281	<0.001
	Accident Time x SpeedLimitZone6	43.040	55	0.783	2.340	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	3520.937	4	880.234	2632.666	<0.001	0.010
	Car per Accident x OSGR Easting Band	5.693	8	0.712	2.128	0.030	<0.001
	Car per Accident x OSGR Northing Band	19.262	12	1.605	4.801	<0.001	<0.001
	Car per Accident x Speed Limit Zone	291.454	10	29.145	87.170	<0.001	0.001
	Casualty per Car Accident x OSGR Easting Band	55.044	8	6.881	20.579	<0.001	<0.001
	Casualty per Car Accident x OSGR Northing Band	121.492	12	10.124	30.280	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	899.339	10	89.934	268.981	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	12.493	24	0.521	1.557	0.040	<0.001
	OSGR Easting Band x Speed Limit Zone	15.344	20	0.767	2.295	0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	13.701	30	0.457	1.366	0.087	<0.001
Control	Accident Year	2.014	1	2.014	6.025	0.014	<0.001
	Error	356085.111	1065004	0.334			
	Total	4178017.000	1066287				
	Corrected Total	1445627.855	1066286				
	*R^2 = 0.754 (Adjusted R^2 = 0.753)						
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)						

ANOVA/ ANCOVA for the Car per KSI Accident

ANOVA for the 'car per KSI accident' depending on thirteen categorical explanatory factors with common sample size, $n = 1066286$; including main effects and two-way interaction effects, were performed by fulfilling the assumptions. The output is displayed in Table 4.2a. All nominal main effects, except road surface conditions ($F_{(4,\ 1065005)} = 1.394,\ p = 0.223;\ \eta^2_{(P)} < 0.001$), had statistically significant mean differences ($p \leq 0.05$). In two-way interactions of nominal-by-nominal factors, all unique pairs (except two pairs: lights conditions × road surface conditions and England region × lights conditions) had significant ($p \leq 0.05$) mean differences statistically.

All the ordinal main effects, except OSGR easting band ($F_{(4,\ 1065005)} = 1.712,\ p = 0.144;\ \eta^2_{(P)} < 0.001$) and OSGR northing band ($F_{(6,\ 1065005)} = 1.350,\ p = 0.231;\ \eta^2_{(P)} < 0.001$), were statistically significant ($p \leq 0.05$) mean differences. In two-way interactions, only nine pairs (i.e., accident month × accident day; accident day × OSGR easting band; accident day × OSGR northing band; accident month × OSGR easting band; accident month × OSGR northing band; accident time × OSGR easting band; accident time × OSGR northing band; casualty per car accident × OSGR easting band; and OSGR easting band × OSGR northing band) out of 28 unique pairs of ordinal by ordinal factors, were not statistically significant ($p > 0.05$), remaining 19 pairs had significant interactions ($p \leq 0.05$).

Table 4.2a: Analysis of Variance (ANOVA) for the Car per KSI Accident

ANOVA Tests of Between-Subjects Effects for the Number of Car per KSI Accident							
	Source	Type III SS	df	Mean Square	F	p-Value	Partial Eta²
	Corrected Model*	588095.186	1281	459.091	2352.214	<0.001	0.739
	Intercept	1575.502	1	1575.502	8072.302	<0.001	0.008
Main Effects	England Region	4.797	8	0.600	3.072	0.002	<0.001
	Lights Conditions	13.704	4	3.426	17.554	<0.001	<0.001
	Road Surface Conditions	1.088	4	0.272	1.394	0.233	<0.001
	Road Type	177.849	4	44.462	227.809	<0.001	0.001
	Weather Conditions	5.769	7	0.824	4.222	<0.001	<0.001
	Accident Month	9.203	11	0.837	4.287	<0.001	<0.001
	Accident Day	4.527	6	0.754	3.866	0.001	<0.001
	Accident Time	20.134	11	1.830	9.378	<0.001	<0.001
	Casualty per Car Accident	60.293	2	30.146	154.459	<0.001	<0.001
	Car per Accident	25509.567	2	12754.783	65350.885	<0.001	0.109
	OSGR Easting Band	1.337	4	0.334	1.712	0.144	<0.001
	OSGR Northing Band	1.581	6	0.263	1.350	0.231	<0.001
	Speed Limit Zone	433.506	5	86.701	444.226	<0.001	0.002
Interaction Effects	England Region x Lights Conditions	7.832	32	0.245	1.254	0.153	<0.001
	England Region x Road Surface Conditions	9.570	32	0.299	1.532	0.028	<0.001
	England Region x Road Type	14.853	32	0.464	2.378	<0.001	<0.001
	England Region x Weather Conditions	236.892	56	4.230	21.674	<0.001	0.001
	Lights Conditions x Road Surface Conditions	3.055	16	0.191	0.978	0.477	<0.001
	Lights Conditions x Road Type	26.919	16	1.682	8.620	<0.001	<0.001
	Lights Conditions x Weather Conditions	274.416	28	9.801	50.215	<0.001	0.001
	Road Surface Condition x Road Type	21.180	16	1.324	6.782	<0.001	<0.001
	Road Surface Conditions x Weather Conditions	69.944	28	2.498	12.799	<0.001	<0.001
	Road Type x Weather Conditions	3397.603	28	121.343	621.717	<0.001	0.016
	Accident Month x Accident Day	13.215	66	0.200	1.026	0.419	<0.001
	Accident Day x Accident Time	23.070	66	0.350	1.791	<0.001	<0.001
	Accident Day x Car per Accident	20.135	12	1.678	8.597	<0.001	<0.001
	Accident Day x Casualty per Car Accident	26.927	12	2.244	11.497	<0.001	<0.001
	Accident Day x OSGR Easting Band	4.171	24	0.174	0.890	0.617	<0.001
	Accident Day x OSGR Northing Band	7.375	36	0.205	1.050	0.388	<0.001
	Accident Day x Speed Limit Zone	39.231	30	1.308	6.700	<0.001	<0.001
	Accident Month x Accident Time	50.732	121	0.419	2.148	<0.001	<0.001
	Accident Month x Car per Accident	78.624	22	3.574	18.311	<0.001	<0.001
	Accident Month x Casualty per Car Accident	37.864	22	1.721	8.818	<0.001	<0.001
	Accident Month x OSGR Easting Band	5.959	44	0.135	0.694	0.939	<0.001
	Accident Month x OSGR Northing Band	9.971	66	0.151	0.774	0.912	<0.001
	Accident Month x Speed Limit Zone	69.168	55	1.258	6.443	<0.001	<0.001
	Accident Time x Car per Accident	121.784	22	5.536	28.363	<0.001	0.001
	Accident Time x Casualty per Car Accident	128.298	22	5.832	29.880	<0.001	0.001
	Accident Time x OSGR Easting Band	6.660	44	0.151	0.776	0.858	<0.001
	Accident Time x OSGR Northing Band	9.542	66	0.145	0.741	0.943	<0.001
	Accident Time x SpeedLimitZone6	76.183	55	1.385	7.097	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	1420.732	4	355.183	1819.829	<0.001	0.007
	Car per Accident x OSGR Easting Band	9.908	8	1.239	6.346	<0.001	<0.001
	Car per Accident x OSGR Northing Band	28.512	12	2.376	12.174	<0.001	<0.001
	Car per Accident x Speed Limit Zone	4002.225	10	400.223	2050.595	<0.001	0.019
	Casualty per Car Accident x OSGR Easting Band	1.639	8	0.205	1.050	0.395	<0.001
	Casualty per Car Accident x OSGR Northing Band	8.189	12	0.682	3.496	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	697.737	10	69.774	357.495	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	4.326	24	0.180	0.923	0.570	<0.001
	OSGR Easting Band x Speed Limit Zone	11.311	20	0.566	2.898	<0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	13.791	30	0.460	2.355	<0.001	<0.001
	Error	207861.118	1065005	0.195			
	Total	4140252.000	1066287				
	Corrected Total	795956.304	1066286				
	*R^2 = 0.739 (Adjusted R^2 = 0.739)						
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)						

Again, ANCOVA for the car per KSI accident defending on thirteen categorical explanatory factors controlled by accident year (covariate) with common sample size, $n = 1066286$; including main effects and two-way interaction effects, were performed by fulfilling the assumptions. The output is displayed in Table 4.2b. All nominal main effects, except road surface conditions ($F_{(4,\ 1065004)} = 1.415,\ p = 0.226;\ \eta^2_{(P)} < 0.001$), had statistically significant adjusted mean differences ($p \leq 0.05$). In two-way interactions of nominal by nominal factors, all unique pairs, (except, England region × lights conditions, $F_{(32,\ 1065004)} = 1.266,\ p = 0.144;\ \eta^2_{(P)} < 0.001$; and lights conditions × road surface conditions, $F_{(16,\ 1065004)} = 0.992,\ p = 0.462;\ \eta^2_{(P)} < 0.001$), had significant ($p \leq 0.05$) adjusted mean differences statistically.

All the ordinal main effects, except OSGR easting band ($F_{(4,\ 1065004)} = 1.679,\ p = 0.152;\ \eta^2_{(P)} < 0.001$) and OSGR northing band ($F_{(6,\ 1065004)} = 1.294,\ p = 0.256;\ \eta^2_{(P)} < 0.001$), had statistically significant ($p \leq 0.05$) adjusted mean differences. In two-way interactions of ordinal by ordinal factors, only nine pairs (i.e., accident month × accident day; accident day × OSGR easting band; accident day × OSGR northing band; accident month × OSGR easting band; accident month × OSGR northing band; accident time × OSGR easting band; accident time × OSGR northing band; casualty per car accident × OSGR easting band; and OSGR easting band × OSGR northing band), had not statistically significant ($p > 0.05$) adjusted mean differences, while remaining 19 pairs had significant interactions ($p \leq 0.05$) in adjusted mean differences. The controlled variable, accident year was also statistically significant ($F_{(1,\ 1065004)} = 43.714,\ p < 0.001;\ \eta^2_{(P)} < 0.001$).

Table 4.2b: ANCOVA for the Car per KSI Accident Controlled by Accident Year

ANCOVA Tests of Between-Subjects Effects for the Number of Car per KSI Accident Controlled by Accident Year

	Source	Type III SS	df	Mean Square	F	p-Value	Partial Eta²
	Corrected Model*	588103.718	1282	458.739	2350.508	<0.001	0.739
	Intercept	58.365	1	58.365	299.053	<0.001	<0.001
Main Effects	England Region	4.692	8	0.586	3.005	0.002	<0.001
	Lights Conditions	13.916	4	3.479	17.826	<0.001	<0.001
	Road Surface Conditions	1.105	4	0.276	1.415	0.226	<0.001
	Road Type	176.746	4	44.187	226.405	<0.001	0.001
	Weather Conditions	5.804	7	0.829	4.248	<0.001	<0.001
	Accident Month	9.154	11	0.832	4.264	<0.001	<0.001
	Accident Day	4.503	6	0.751	3.845	0.001	<0.001
	Accident Time	19.921	11	1.811	9.279	<0.001	<0.001
	Casualty per Car Accident	60.379	2	30.190	154.687	<0.001	<0.001
	Car per Accident	25499.262	2	12749.631	65327.107	<0.001	0.109
	OSGR Easting Band	1.310	4	0.328	1.679	0.152	<0.001
	OSGR Northing Band	1.515	6	0.253	1.294	0.256	<0.001
	Speed Limit Zone	436.605	5	87.321	447.419	<0.001	0.002
Interaction Effects	England Region x Lights Conditions	7.904	32	0.247	1.266	0.144	<0.001
	England Region x Road Surface Conditions	9.602	32	0.300	1.537	0.027	<0.001
	England Region x Road Type	14.708	32	0.460	2.355	<0.001	<0.001
	England Region x Weather Conditions	236.618	56	4.225	21.650	<0.001	0.001
	Lights Conditions x Road Surface Conditions	3.099	16	0.194	0.992	0.462	<0.001
	Lights Conditions x Road Type	27.028	16	1.689	8.655	<0.001	<0.001
	Lights Conditions x Weather Conditions	274.960	28	9.820	50.316	<0.001	0.001
	Road Surface Condition x Road Type	21.264	16	1.329	6.809	<0.001	<0.001
	Road Surface Conditions x Weather Conditions	69.743	28	2.491	12.763	<0.001	<0.001
	Road Type x Weather Conditions	3397.687	28	121.346	621.758	<0.001	0.016
	Accident Month x Accident Day	13.260	66	0.201	1.029	0.411	<0.001
	Accident Day x Accident Time	23.153	66	0.351	1.797	<0.001	<0.001
	Accident Day x Car per Accident	20.203	12	1.684	8.627	<0.001	<0.001
	Accident Day x Casualty per Car Accident	26.713	12	2.226	11.406	<0.001	<0.001
	Accident Day x OSGR Easting Band	4.180	24	0.174	0.892	0.614	<0.001
	Accident Day x OSGR Northing Band	7.362	36	0.204	1.048	0.391	<0.001
	Accident Day x Speed Limit Zone	39.242	30	1.308	6.702	<0.001	<0.001
	Accident Month x Accident Time	50.603	121	0.418	2.143	<0.001	<0.001
	Accident Month x Car per Accident	78.863	22	3.585	18.367	<0.001	<0.001
	Accident Month x Casualty per Car Accident	37.746	22	1.716	8.791	<0.001	<0.001
	Accident Month x OSGR Easting Band	5.978	44	0.136	0.696	0.937	<0.001
	Accident Month x OSGR Northing Band	9.932	66	0.150	0.771	0.915	<0.001
	Accident Month x Speed Limit Zone	69.208	55	1.258	6.447	<0.001	<0.001
	Accident Time x Car per Accident	121.943	22	5.543	28.401	<0.001	0.001
	Accident Time x Casualty per Car Accident	128.476	22	5.840	29.922	<0.001	0.001
	Accident Time x OSGR Easting Band	6.686	44	0.152	0.779	0.854	<0.001
	Accident Time x OSGR Northing Band	9.549	66	0.145	0.741	0.943	<0.001
	Accident Time x SpeedLimitZone6	75.917	55	1.380	7.073	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	1418.573	4	354.643	1817.137	<0.001	0.007
	Car per Accident x OSGR Easting Band	9.833	8	1.229	6.298	<0.001	<0.001
	Car per Accident x OSGR Northing Band	28.640	12	2.387	12.229	<0.001	<0.001
	Car per Accident x Speed Limit Zone	3992.690	10	399.269	2045.792	<0.001	0.019
	Casualty per Car Accident x OSGR Easting Band	1.630	8	0.204	1.044	0.400	<0.001
	Casualty per Car Accident x OSGR Northing Band	8.161	12	0.680	3.484	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	698.582	10	69.858	357.942	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	4.328	24	0.180	0.924	0.569	<0.001
	OSGR Easting Band x Speed Limit Zone	11.475	20	0.574	2.940	<0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	13.671	30	0.456	2.335	<0.001	<0.001
Control	Accident Year	8.531	1	8.531	43.714	<0.001	<0.001
	Error	207852.586	1065004	0.195			
	Total	4140252.000	1066287				
	Corrected Total	795956.304	1066286				

*R^2 = 0.739 (Adjusted R^2 = 0.739)

Black Mark: Highly Significant ($p < 0.001$); Blue Mark: Significant ($0.001 \leq p \leq 0.05$); Red Mark: not Significant ($p > 0.05$)

MANOVA/ MANCOVA for the KSI Car Accident Statistics

Multivariate analysis of variance for response factors as the 'casualty per KSI car accident' and 'car per KSI accident' depending on thirteen categorical explanatory factors with common sample size, $n = 1066286$; including main effects and two-way interaction effects, were performed by fulfilling the assumptions. The output for multivariate test (Wilks' Lambda) for MANOVA is displayed in Table 4.3a followed by MANOVA tests of between-subject effects in Table 4.3b. Wilks' Lambda tests for MANOVA indicate that each of all nominal main effects, except road surface conditions ($F_{(8,\ 2130008)} = 1.062$, $p = 0.387$; Wilks $\Lambda = 1.000$; $\eta^2_{(P)} < 0.001$), had statistically significant mean differences ($p \leq 0.05$) between their own groups on the combined responses of the casualty per KSI car accident and car per KSI accident. In two-way interactions of nominal-by-nominal factors, each of all unique pairs (except, England region × road surface conditions, and lights conditions × road surface conditions) had statistically significant ($p \leq 0.05$) mean differences between their own groups on the combined responses.

Again, each of all ordinal main effects, except OSGR easting band ($F_{(8,\ 2130008)} = 1.379$, $p = 0.200$; Wilks $\Lambda = 1.000$; $\eta^2_{(P)} < 0.001$), had statistically significant ($p \leq 0.05$) mean differences between their own groups on the combined responses. Also, in two-way interactions, only six pairs (i.e., accident day × OSGR easting band; accident day × OSGR northing band; accident month × OSGR northing band; accident time × OSGR easting band;

accident time × OSGR northing band; and OSGR easting band × OSGR northing band) out of 28 unique pairs of ordinal-by-ordinal factors, had no statistically significant ($p > 0.05$) mean differences between their own groups, while remaining 22 pairs had significant interactions ($p \leq 0.05$).

Table 4.3a: Multivariate Test (i.e., Wilks' Lambda) for MANOVA of Combined Response Factors

Multivariate Tests (Wilks' Lambda) of MANOVA for Combined of Number of Casualty per KSI Car Accident and Number of Car per Accident							
	Effect	Wilks' Lambda	F	Hypothesis df	Error df	p-Value	Partial Eta^2
	Intercept	0.990	5619.939	2	1065004	<0.001	0.010
Main Effects	England Region	1.000	2.183	16	2130008	0.004	<0.001
	Lights Conditions	1.000	8.780	8	2130008	<0.001	<0.001
	Road Surface Conditions	1.000	1.062	8	2130008	0.387	<0.001
	Road Type	0.999	114.144	8	2130008	<0.001	<0.001
	Weather Conditions	1.000	2.735	14	2130008	<0.001	<0.001
	Accident Month	1.000	6.030	22	2130008	<0.001	<0.001
	Accident Day	1.000	27.347	12	2130008	<0.001	<0.001
	Accident Time	1.000	9.289	22	2130008	<0.001	<0.001
	Casualty per Car Accident	0.889	32350.243	4	2130008	<0.001	0.057
	Car per Accident	0.908	26206.694	4	2130008	<0.001	0.047
	OSGR Easting Band	1.000	1.379	8	2130008	0.200	<0.001
	OSGR Northing Band	1.000	1.877	12	2130008	0.032	<0.001
	Speed Limit Zone	0.998	246.123	10	2130008	<0.001	0.001
Interaction Effects	England Region x Lights Conditions	1.000	1.648	64	2130008	0.001	<0.001
	England Region x Road Surface Conditions	1.000	1.239	64	2130008	0.094	<0.001
	England Region x Road Type	1.000	1.471	64	2130008	0.008	<0.001
	England Region x Weather Conditions	0.999	12.011	112	2130008	<0.001	0.001
	Lights Conditions x Road Surface Conditions	1.000	0.912	32	2130008	0.610	<0.001
	Lights Conditions x Road Type	1.000	4.582	32	2130008	<0.001	<0.001
	Lights Conditions x Weather Conditions	0.999	25.477	56	2130008	<0.001	0.001
	Road Surface Condition x Road Type	1.000	4.072	32	2130008	<0.001	<0.001
	Road Surface Conditions x Weather Conditions	1.000	7.383	56	2130008	<0.001	<0.001
	Road Type x Weather Conditions	0.984	310.106	56	2130008	<0.001	0.008
	Accident Month x Accident Day	1.000	1.370	132	2130008	0.003	<0.001
	Accident Day x Accident Time	1.000	2.479	132	2130008	<0.001	<0.001
	Accident Day x Car per Accident	1.000	11.998	24	2130008	<0.001	<0.001
	Accident Day x Casualty per Car Accident	0.996	167.825	24	2130008	<0.001	0.002
	Accident Day x OSGR Easting Band	1.000	0.770	48	2130008	0.876	<0.001
	Accident Day x OSGR Northing Band	1.000	1.249	72	2130008	0.075	<0.001
	Accident Day x Speed Limit Zone	1.000	4.927	60	2130008	<0.001	<0.001
	Accident Month x Accident Time	1.000	1.626	242	2130008	<0.001	<0.001
	Accident Month x Car per Accident	1.000	11.209	44	2130008	<0.001	<0.001
	Accident Month x Casualty per Car Accident	0.999	25.117	44	2130008	<0.001	0.001
	Accident Month x OSGR Easting Band	1.000	0.800	88	2130008	<0.001	<0.001
	Accident Month x OSGR Northing Band	1.000	1.046	132	2130008	0.341	<0.001
	Accident Month x Speed Limit Zone	1.000	3.916	110	2130008	<0.001	<0.001
	Accident Time x Car per Accident	0.999	17.216	44	2130008	<0.001	<0.001
	Accident Time x Casualty per Car Accident	0.997	64.883	44	2130008	<0.001	0.001
	Accident Time x OSGR Easting Band	1.000	0.962	88	2130008	0.582	<0.001
	Accident Time x OSGR Northing Band	1.000	0.940	132	2130008	0.677	<0.001
	Accident Time x SpeedLimitZone6	1.000	4.438	110	2130008	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	0.986	1940.666	8	2130008	<0.001	0.007
	Car per Accident x OSGR Easting Band	1.000	3.961	16	2130008	<0.001	<0.001
	Car per Accident x OSGR Northing Band	1.000	8.912	24	2130008	<0.001	<0.001
	Car per Accident x Speed Limit Zone	0.981	1024.886	20	2130008	<0.001	0.010
	Casualty per Car Accident x OSGR Easting Band	1.000	11.509	16	2130008	<0.001	<0.001
	Casualty per Car Accident x OSGR Northing Band	1.000	17.414	24	2130008	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	0.995	269.833	20	2130008	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	1.000	1.303	48	2130008	0.077	<0.001
	OSGR Easting Band x Speed Limit Zone	1.000	2.484	40	2130008	<0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	1.000	1.831	60	2130008	<0.001	<0.001
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)						

To determine which response variable would be appearing to contribute to the statistically significant MANOVA, it was to inspect the ANOVA result for each response factor. These results are shown in the MANOVA Tests of Between-Subjects Effects Table 4.3b. MANOVA tests of between-subject effects indicate that there was only statistically significant mean differences in the casualty per KSI car accident on the groups of road type nominal main effect ($F_{(4,\ 1065005)} = 7.471,\ p < 0.001;\ \eta^2_{(P)} < 0.001$), while all main effects, except road surface conditions ($F_{(4,\ 1065005)} = 1.394,\ p = 0.233;\ \eta^2_{(P)} < 0.001$), had significant mean differences in the car per KSI accident. In two-way interactions of nominal-by-nominal factors, there was statistically significant ($p \leq 0$) mean differences in the number of casualty per KSI car accident on the groups of England region × lights conditions as well as England region × weather conditions, lights conditions × weather conditions, road surface conditions × weather conditions, and road type × weather conditions; while all interaction effects, except England region × lights conditions and lights conditions × road surface conditions, had significant mean differences in the number of car per KSI car accident.

Again, there were statistically significant mean differences in the casualty per KSI car accident on the groups of all ordinal main effects, except OSGR easting band ($F_{(4,\ 1065005)} = 1.480,\ p = 0.205;\ \eta^2_{(P)} < 0.001$); while all main effects, except OSGR easting band and OSGR northing band, had significant ($p \leq 0$) mean differences in the car per KSI car accident. In two-way interactions of ordinal by ordinal factors, there was statistically significant mean differences ($p \leq 0$) in the number of casualty per KSI car accident on the groups of all interaction effects, (except, accident month × accident day, accident day × OSGR easting band, accident day × OSGR northing band, accident month × OSGR easting band, accident month × OSGR northing band, accident time × OSGR easting band, accident time × OSGR northing band, casualty per KSI accident × OSGR easting band, and OSGR easting band × OSGR northing band); on the other hand, all interaction effects, (except, accident day × OSGR easting band, accident month × Accident time, accident month × OSGR easting band, accident time × OSGR easting band, accident time × OSGR northing band, and OSGR northing band × speed limit zone), had significant mean differences ($p \leq 0$) in the number of car per KSI accident.

Table 4.3b: Multivariate Analysis of Variance (MANOVA) for Response Factors

MANOVA Tests of Between-Subjects Effects for Combined of Number of Casualty per KSI Car Accident and the Number of Car per KSI Accident

	Response Variable →	Number of Casualty per KSI Car Accident						Number of Car per KSI Accident					
	Source	Type III SS	df	Mean Square	F	p-Value	Partial Eta²	Type III SS	df	Mean Square	F	p-Value	Partial Eta²
	Corrected Model*	1089540.730	1281	850.539	2543.840	<0.001	0.754	588095.186	1281	459.091	2352.214	<0.001	0.739
	Intercept	1786.994	1	1786.994	5344.640	<0.001	0.005	1575.502	1	1575.502	8072.302	<0.001	0.008
Main Effects	England Region	2.809	8	0.351	1.050	0.395	<0.001	4.797	8	0.600	3.072	0.002	<0.001
	Lights Conditions	1.049	4	0.262	0.784	0.535	<0.001	13.704	4	3.426	17.554	<0.001	<0.001
	Road Surface Conditions	1.042	4	0.260	0.779	0.539	<0.001	1.088	4	0.272	1.394	0.233	<0.001
	Road Type	9.991	4	2.498	7.471	<0.001	<0.001	177.849	4	44.462	227.809	<0.001	0.001
	Weather Conditions	2.703	7	0.386	1.155	0.325	<0.001	5.769	7	0.824	4.222	<0.001	<0.001
	Accident Month	22.217	11	2.020	6.041	<0.001	<0.001	9.203	11	0.837	4.287	<0.001	<0.001
	Accident Day	92.852	6	15.475	46.284	<0.001	<0.001	4.527	6	0.754	3.866	0.001	<0.001
	Accident Time	24.524	11	2.229	6.668	<0.001	<0.001	20.134	11	1.830	9.378	<0.001	<0.001
	Casualty per Car Accident	162.360	2	81.180	242.798	<0.001	<0.001	25509.567	2	12754.783	65350.885	<0.001	0.109
	Car per Accident	35121.103	2	17560.552	52521.066	<0.001	0.090	60.293	2	30.146	154.459	<0.001	<0.001
	OSGR Easting Band	1.980	4	0.495	1.480	0.205	<0.001	1.337	4	0.334	1.712	0.144	<0.001
	OSGR Northing Band	4.611	6	0.768	2.298	0.032	<0.001	1.581	6	0.263	1.350	0.231	<0.001
	Speed Limit Zone	150.866	5	30.173	90.244	<0.001	<0.001	433.506	5	86.701	444.226	<0.001	0.002
Interaction Effects	England Region x Lights Conditions	19.994	32	0.625	1.869	0.002	<0.001	7.832	32	0.245	1.254	0.153	<0.001
	England Region x Road Surface Conditions	11.070	32	0.346	1.035	0.413	<0.001	9.570	32	0.299	1.532	0.028	<0.001
	England Region x Road Type	7.687	32	0.240	0.718	0.879	<0.001	14.853	32	0.464	2.378	<0.001	<0.001
	England Region x Weather Conditions	53.437	56	0.954	2.854	<0.001	<0.001	236.892	56	4.230	21.674	<0.001	0.001
	Lights Conditions x Road Surface Conditions	4.831	16	0.302	0.903	0.565	<0.001	3.055	16	0.191	0.978	0.477	<0.001
	Lights Conditions x Road Type	6.432	16	0.402	1.202	0.257	<0.001	26.919	16	1.682	8.620	<0.001	<0.001
	Lights Conditions x Weather Conditions	28.093	28	1.003	3.001	<0.001	<0.001	274.416	28	9.801	50.215	<0.001	0.001
	Road Surface Condition x Road Type	4.377	16	0.274	0.818	0.666	<0.001	21.180	16	1.324	6.782	<0.001	<0.001
	Road Surface Conditions x Weather Conditions	20.533	28	0.733	2.193	<0.001	<0.001	69.944	28	2.498	12.799	<0.001	<0.001
	Road Type x Weather Conditions	308.202	28	11.007	32.921	<0.001	0.001	3397.603	28	121.343	621.717	<0.001	0.016
	Accident Month x Accident Day	37.735	66	0.572	1.710	<0.001	<0.001	13.215	66	0.200	1.026	0.419	<0.001
	Accident Day x Accident Time	68.580	66	1.039	3.108	<0.001	<0.001	23.070	66	0.350	1.791	<0.001	<0.001
	Accident Day x Car per Accident	56.564	12	4.714	14.098	<0.001	<0.001	20.135	12	1.678	8.597	<0.001	<0.001
	Accident Day x Casualty per Car Accident	1194.836	12	99.570	297.798	<0.001	0.003	26.927	12	2.244	11.497	<0.001	<0.001
	Accident Day x OSGR Easting Band	5.294	24	0.221	0.660	0.894	<0.001	4.171	24	0.174	0.890	0.617	<0.001
	Accident Day x OSGR Northing Band	17.535	36	0.487	1.457	0.038	<0.001	7.375	36	0.205	1.050	0.388	<0.001
	Accident Day x Speed Limit Zone	24.701	30	0.823	2.463	<0.001	<0.001	39.231	30	1.308	6.700	<0.001	<0.001
	Accident Month x Accident Time	46.628	121	0.385	1.153	0.120	<0.001	50.732	121	0.419	2.148	<0.001	<0.001
	Accident Month x Car per Accident	16.581	22	0.754	2.254	0.001	<0.001	78.624	22	3.574	18.311	<0.001	<0.001
	Accident Month x Casualty per Car Accident	256.069	22	11.639	34.812	<0.001	0.001	37.864	22	1.721	8.818	<0.001	<0.001
	Accident Month x OSGR Easting Band	13.627	44	0.310	0.926	0.611	<0.001	5.959	44	0.135	0.694	0.939	<0.001
	Accident Month x OSGR Northing Band	28.974	66	0.439	1.313	0.045	<0.001	9.971	66	0.151	0.774	0.912	<0.001
	Accident Month x Speed Limit Zone	26.251	55	0.477	1.428	0.020	<0.001	69.168	55	1.258	6.443	<0.001	<0.001
	Accident Time x Car per Accident	32.492	22	1.477	4.417	<0.001	<0.001	121.784	22	5.536	28.363	<0.001	0.001
	Accident Time x Casualty per Car Accident	612.014	22	27.819	83.202	<0.001	0.002	128.298	22	5.832	29.880	<0.001	0.001
	Accident Time x OSGR Easting Band	16.629	44	0.378	1.130	0.256	<0.001	6.660	44	0.151	0.776	0.858	<0.001
	Accident Time x OSGR Northing Band	24.136	66	0.366	1.094	0.281	<0.001	9.542	66	0.145	0.741	0.943	<0.001
	Accident Time x SpeedLimitZone6	43.032	55	0.782	2.340	<0.001	<0.001	76.183	55	1.385	7.097	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	3519.299	4	879.825	2631.428	<0.001	0.010	1420.732	4	355.183	1819.829	<0.001	0.007
	Car per Accident x OSGR Easting Band	5.649	8	0.706	2.112	0.031	<0.001	9.908	8	1.239	6.346	<0.001	<0.001
	Car per Accident x OSGR Northing Band	19.171	12	1.598	4.778	<0.001	<0.001	28.512	12	2.376	12.174	<0.001	<0.001
	Car per Accident x Speed Limit Zone	290.602	10	29.060	86.915	<0.001	0.001	4002.225	10	400.223	2050.595	<0.001	0.019
	Casualty per Car Accident x OSGR Easting Band	55.023	8	6.878	20.571	<0.001	<0.001	1.639	8	0.205	1.050	0.395	<0.001
	Casualty per Car Accident x OSGR Northing Band	121.394	12	10.116	30.256	<0.001	<0.001	8.189	12	0.682	3.496	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	900.013	10	90.001	269.181	<0.001	0.003	697.737	10	69.774	357.495	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	12.573	24	0.524	1.567	0.038	<0.001	4.326	24	0.180	0.923	0.570	<0.001
	OSGR Easting Band x Speed Limit Zone	15.456	20	0.773	2.311	0.001	<0.001	11.311	20	0.566	2.898	<0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	13.693	30	0.456	1.365	0.088	<0.001	13.791	30	0.460	2.355	<0.001	<0.001
	Error	356087.125	1065005	0.334				207861.118	1065005	0.195			
	Total	4178017.000	1066287					4140252.000	1066287				
	Corrected Total	1445627.855	1066286					795956.304	1066286				

*R^2 = 0.754 (Adjusted R^2 = 0.753) | *R^2 = 0.739 (Adjusted R^2 = 0.739)

Black Mark: Highly Significant ($p < 0.001$); Blue Mark: Significant ($0.001 \leq p \leq 0.05$); Red Mark: not Significant ($p > 0.05$)

Multivariate analysis of covariance (MANCOVA) for response factors as the 'casualty per KSI car accident' and 'car per KSI accident' based on thirteen categorical explanatory factors with common sample size, $n = 1066286$; including main effects and two-way interaction effects controlled by accident year as covariate, were performed by fulfilling the assumptions. The output for multivariate test (Wilks' Lambda) for MANCOVA is displayed in Table 4.3c followed by MANCOVA tests of between-subject effects in Table 4.3d. Wilks' Lambda tests for MANCOVA indicate that each of all nominal main effects, except road surface conditions ($F_{(8,\ 2130006)} = 1.071,\ p = 0.380$; Wilks $\Lambda = 1.000$; $\eta^2_{(P)} < 0.001$) controlled by accident year, had statistically significant adjusted mean differences ($p \leq 0.05$) between their own groups on the combined responses of the casualty per KSI car accident, and car per KSI car accident. In two-way interactions of nominal-by-nominal factors, each of all unique pairs (except, two pairs: England region × road surface conditions, and lights conditions × road surface conditions) had statistically significant ($p \leq 0.05$) adjusted mean differences between their own groups on the combined responses.

Again, each of all ordinal main effects, except OSGR easting band ($F_{(8,\ 2130006)} = 1.360,\ p = 0.209$; Wilks $\Lambda = 1.000$; $\eta^2_{(P)} < 0.001$), had statistically significant ($p \leq 0.05$) adjusted mean differences between their own groups on the combined responses. Also, in two-way interactions, only six pairs (i.e., accident day × OSGR easting band; accident day × OSGR northing band; accident month × OSGR northing band; accident time × OSGR easting band;

accident time × OSGR northing band; and OSGR easting band × OSGR northing band) out of 28 unique pairs of ordinal by ordinal factors, had no statistically significant ($p > 0.05$) adjusted mean differences between their own groups, while remaining 22 pairs had significant interactions ($p \leq 0.05$).

Table 4.3c: Multivariate Test (i.e., Wilks' Lambda) for MANCOVA

Multivariate Tests (Wilks' Lambda) of MANCOVA for Number of Casualty per KSI Car Accident and Number of Car per Accident Controlled by Accident Year							
	Effect	Wilks' Lambda	F	Hypothesis df	Error df	p-Value	Partial Eta^2
	Intercept	0.999	321.493	2	1065003	<0.001	0.001
Main Effects	England Region	1.000	2.140	16	2130006	0.005	<0.001
	Lights Conditions	1.000	8.916	8	2130006	<0.001	<0.001
	Road Surface Conditions	1.000	1.071	8	2130006	0.380	<0.001
	Road Type	0.999	113.427	8	2130006	<0.001	<0.001
	Weather Conditions	1.000	2.749	14	2130006	<0.001	<0.001
	Accident Month	1.000	6.007	22	2130006	<0.001	<0.001
	Accident Day	1.000	27.307	12	2130006	<0.001	<0.001
	Accident Time	1.000	9.180	22	2130006	<0.001	<0.001
	Casualty per Car Accident	0.889	32338.374	4	2130006	<0.001	0.057
	Car per Accident	0.908	26205.507	4	2130006	<0.001	0.047
	OSGR Easting Band	1.000	1.360	8	2130006	0.209	<0.001
	OSGR Northing Band	1.000	1.821	12	2130006	0.039	<0.001
	Speed Limit Zone	0.998	247.663	10	2130006	<0.001	0.001
Interaction Effects	England Region x Lights Conditions	1.000	1.654	64	2130006	0.001	<0.001
	England Region x Road Surface Conditions	1.000	1.241	64	2130006	0.093	<0.001
	England Region x Road Type	1.000	1.459	64	2130006	0.010	<0.001
	England Region x Weather Conditions	0.999	11.999	112	2130006	<0.001	0.001
	Lights Conditions x Road Surface Conditions	1.000	0.919	32	2130006	0.598	<0.001
	Lights Conditions x Road Type	1.000	4.600	32	2130006	<0.001	<0.001
	Lights Conditions x Weather Conditions	0.999	25.526	56	2130006	<0.001	0.001
	Road Surface Condition x Road Type	1.000	4.092	32	2130006	<0.001	<0.001
	Road Surface Conditions x Weather Conditions	1.000	7.363	56	2130006	<0.001	<0.001
	Road Type x Weather Conditions	0.984	310.122	56	2130006	<0.001	0.008
	Accident Month x Accident Day	1.000	1.370	132	2130006	0.003	<0.001
	Accident Day x Accident Time	1.000	2.482	132	2130006	<0.001	<0.001
	Accident Day x Car per Accident	1.000	12.015	24	2130006	<0.001	<0.001
	Accident Day x Casualty per Car Accident	0.996	167.543	24	2130006	<0.001	0.002
	Accident Day x OSGR Easting Band	1.000	0.771	48	2130006	0.875	<0.001
	Accident Day x OSGR Northing Band	1.000	1.247	72	2130006	0.076	<0.001
	Accident Day x Speed Limit Zone	1.000	4.931	60	2130006	<0.001	<0.001
	Accident Month x Accident Time	1.000	1.625	242	2130006	<0.001	<0.001
	Accident Month x Car per Accident	1.000	11.238	44	2130006	<0.001	<0.001
	Accident Month x Casualty per Car Accident	0.999	25.068	44	2130006	<0.001	0.001
	Accident Month x OSGR Easting Band	1.000	0.801	88	2130006	0.915	<0.001
	Accident Month x OSGR Northing Band	1.000	1.045	132	2130006	0.344	<0.001
	Accident Month x Speed Limit Zone	1.000	3.919	110	2130006	<0.001	<0.001
	Accident Time x Car per Accident	0.999	17.226	44	2130006	<0.001	<0.001
	Accident Time x Casualty per Car Accident	0.997	64.882	44	2130006	<0.001	0.001
	Accident Time x OSGR Easting Band	1.000	0.963	88	2130006	0.579	<0.001
	Accident Time x OSGR Northing Band	1.000	0.940	132	2130006	0.676	<0.001
	Accident Time x SpeedLimitZone6	1.000	4.425	110	2130006	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	0.986	1940.323	8	2130006	<0.001	0.007
	Car per Accident x OSGR Easting Band	1.000	3.947	16	2130006	<0.001	<0.001
	Car per Accident x OSGR Northing Band	1.000	8.962	24	2130006	<0.001	<0.001
	Car per Accident x Speed Limit Zone	0.981	1022.503	20	2130006	<0.001	0.010
	Casualty per Car Accident x OSGR Easting Band	1.000	11.512	16	2130006	<0.001	<0.001
	Casualty per Car Accident x OSGR Northing Band	1.000	17.427	24	2130006	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	0.995	269.924	20	2130006	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	1.000	1.295	48	2130006	0.082	<0.001
	OSGR Easting Band x Speed Limit Zone	1.000	2.495	40	2130006	<0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	1.000	1.821	60	2130006	<0.001	<0.001
Control	Accident Year	1.000	29.285	2	1065003	<0.001	<0.001
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)						

To determine which response variable would be appearing to contribute to the statistically significant MANCOVA, it was to inspect the one-way ANCOVA result for each response variable. These results are shown in the MANCOVA Tests of between-subjects effects table 4.3d. MANCOVA tests of between-subject effects indicate that there was only statistically significant adjusted mean differences in the casualty per KSI car accident on the groups of only road type nominal main effect ($F_{(4,\ 1065004)} = 7.551,\ p < 0.001;\ \eta^2_{(P)} < 0.001$) controlled by accident year; while all main effects, except road surface conditions ($F_{(4,\ 1065005)} = 1.394,\ p = 0.233;\ \eta^2_{(P)} < 0.001$), had significant adjusted mean differences in the car per KSI car accident. In two-way interactions of nominal by nominal factors, there was statistically significant ($p \leq 0$) adjusted mean differences in the number of casualty per KSI car accident on the groups of England region × weather conditions as well as lights conditions × weather conditions, road surface conditions × weather conditions, and road type × weather conditions; on the other hand, all interaction effects, (except England region × lights conditions and lights conditions × road surface conditions), had significant adjusted mean differences in the number of car per KSI accident.

Again, there were statistically significant mean differences in the casualty per KSI car accident on the groups of all ordinal main effects, except OSGR easting band ($F_{(4,\ 1065005)} = 1.480,\ p = 0.205;\ \eta^2_{(P)} < 0.001$); while all main effects, (except OSGR easting band and OSGR northing band), had significant ($p \leq 0$) adjusted mean differences in the car per KSI accident. In two-way interactions of ordinal by ordinal factors, there was statistically significant adjusted mean differences ($p \leq 0$) in the casualty per KSI car accident on the groups of all interaction effects, (except, accident month × accident day, accident day × OSGR easting band, accident day × OSGR northing band, accident month × OSGR easting band, accident month × OSGR northing band, accident time × OSGR easting band, accident time × OSGR northing band, casualty per KSI accident × OSGR easting band, and OSGR easting band × OSGR northing band); on the other hand, all interaction effects, (except, accident day × OSGR easting band, accident month × Accident time, accident month × OSGR easting band, accident time × OSGR easting band, accident time × OSGR northing band, and OSGR northing band × speed limit zone), had significant adjusted mean differences ($p \leq 0$) in the number of car per KSI accident.

Table 4.3d: MANCOVA for Response Factors Controlled by Accident Year

MANCOVA Tests of Between-Subjects Effects for the Number of Casualty per KSI Car Accident and the Number of Car per KSI Accident Controlled by Accident Year													
	Response Variable →	Number of Casualty per KSI Car Accident						Number of Car per KSI Accident					
	Source	Type III SS	df	Mean Square	F	p-Value	Partial Eta^2	Type III SS	df	Mean Square	F	p-Value	Partial Eta^2
	Corrected Model*	1089542.745	1282	849.877	2541.872	<0.001	0.754	588103.718	1282	458.739	2350.508	<0.001	0.739
	Intercept	156.408	1	156.408	467.796	<0.001	<0.001	58.365	1	58.365	299.053	<0.001	<0.001
Main Effects	England Region	2.791	8	0.349	1.043	0.400	<0.001	4.692	8	0.586	3.005	0.002	<0.001
	Lights Conditions	1.021	4	0.255	0.764	0.549	<0.001	13.916	4	3.479	17.826	<0.001	<0.001
	Road Surface Conditions	1.038	4	0.259	0.776	0.541	<0.001	1.105	4	0.276	1.415	0.226	<0.001
	Road Type	10.098	4	2.525	7.551	<0.001	<0.001	176.746	4	44.187	226.405	<0.001	0.001
	Weather Conditions	2.704	7	0.386	1.155	0.325	<0.001	5.804	7	0.829	4.248	<0.001	<0.001
	Accident Month	22.166	11	2.015	6.027	<0.001	<0.001	9.154	11	0.832	4.264	<0.001	<0.001
	Accident Day	92.778	6	15.463	46.248	<0.001	<0.001	4.503	6	0.751	3.845	0.001	<0.001
	Accident Time	24.278	11	2.207	6.601	<0.001	<0.001	19.921	11	1.811	9.279	<0.001	<0.001
	Casualty per Car Accident	162.669	2	81.334	243.261	<0.001	<0.001	25499.262	2	12749.631	65327.107	<0.001	0.109
	Car per Accident	35119.656	2	17559.828	52519.150	<0.001	0.090	60.379	2	30.190	154.687	<0.001	<0.001
	OSGR Easting Band	1.979	4	0.495	1.480	0.205	<0.001	1.310	4	0.328	1.679	0.152	<0.001
	OSGR Northing Band	4.549	6	0.758	2.268	0.034	<0.001	1.515	6	0.253	1.294	0.256	<0.001
	Speed Limit Zone	150.279	5	30.056	89.893	<0.001	<0.001	436.605	5	87.321	447.419	<0.001	0.002
Interaction Effects	England Region x Lights Conditions	19.988	32	0.625	1.868	0.002	<0.001	7.904	32	0.247	1.266	0.144	<0.001
	England Region x Road Surface Conditions	11.059	32	0.346	1.034	0.414	<0.001	9.602	32	0.300	1.537	0.027	<0.001
	England Region x Road Type	7.691	32	0.240	0.719	0.878	<0.001	14.708	32	0.460	2.355	<0.001	<0.001
	England Region x Weather Conditions	53.464	56	0.955	2.855	<0.001	<0.001	236.618	56	4.225	21.650	<0.001	0.001
	Lights Conditions x Road Surface Conditions	4.827	16	0.302	0.902	0.566	<0.001	3.099	16	0.194	0.992	0.462	<0.001
	Lights Conditions x Road Type	6.420	16	0.401	1.200	0.258	<0.001	27.028	16	1.689	8.655	<0.001	<0.001
	Lights Conditions x Weather Conditions	28.008	28	1.000	2.992	<0.001	<0.001	274.960	28	9.820	50.316	<0.001	0.001
	Road Surface Condition x Road Type	4.412	16	0.276	0.825	0.658	<0.001	21.264	16	1.329	6.809	<0.001	<0.001
	Road Surface Conditions x Weather Conditions	20.532	28	0.733	2.193	<0.001	<0.001	69.743	28	2.491	12.763	<0.001	<0.001
	Road Type x Weather Conditions	308.151	28	11.005	32.916	<0.001	0.001	3397.687	28	121.346	621.758	<0.001	0.016
	Accident Month x Accident Day	37.692	66	0.571	1.708	<0.001	<0.001	13.260	66	0.201	1.029	0.411	<0.001
	Accident Day x Accident Time	68.570	66	1.039	3.107	<0.001	<0.001	23.153	66	0.351	1.797	<0.001	<0.001
	Accident Day x Car per Accident	56.565	12	4.714	14.098	<0.001	<0.001	20.203	12	1.684	8.627	<0.001	<0.001
	Accident Day x Casualty per Car Accident	1193.618	12	99.468	297.496	<0.001	0.003	26.713	12	2.226	11.406	<0.001	<0.001
	Accident Day x OSGR Easting Band	5.288	24	0.220	0.659	0.895	<0.001	4.180	24	0.174	0.892	0.614	<0.001
	Accident Day x OSGR Northing Band	17.527	36	0.487	1.456	0.038	<0.001	7.362	36	0.204	1.048	0.391	<0.001
	Accident Day x Speed Limit Zone	24.743	30	0.825	2.467	<0.001	<0.001	39.242	30	1.308	6.702	<0.001	<0.001
	Accident Month x Accident Time	46.694	121	0.386	1.154	0.118	<0.001	50.603	121	0.418	2.143	<0.001	<0.001
	Accident Month x Car per Accident	16.564	22	0.753	2.252	0.001	<0.001	78.863	22	3.585	18.367	<0.001	<0.001
	Accident Month x Casualty per Car Accident	255.756	22	11.625	34.770	<0.001	0.001	37.746	22	1.716	8.791	<0.001	<0.001
	Accident Month x OSGR Easting Band	13.616	44	0.309	0.926	0.613	<0.001	5.978	44	0.136	0.696	0.937	<0.001
	Accident Month x OSGR Northing Band	28.996	66	0.439	1.314	0.045	<0.001	9.932	66	0.150	0.771	0.915	<0.001
	Accident Month x Speed Limit Zone	26.258	55	0.477	1.428	0.020	<0.001	69.208	55	1.258	6.447	<0.001	<0.001
	Accident Time x Car per Accident	32.388	22	1.472	4.403	<0.001	<0.001	121.943	22	5.543	28.401	<0.001	0.001
	Accident Time x Casualty per Car Accident	611.766	22	27.808	83.169	<0.001	0.002	128.476	22	5.840	29.922	<0.001	0.001
	Accident Time x OSGR Easting Band	16.621	44	0.378	1.130	0.256	<0.001	6.686	44	0.152	0.779	0.854	<0.001
	Accident Time x OSGR Northing Band	24.139	66	0.366	1.094	0.281	<0.001	9.549	66	0.145	0.741	0.943	<0.001
	Accident Time x SpeedLimitZone6	43.040	55	0.783	2.340	<0.001	<0.001	75.917	55	1.380	7.073	<0.001	<0.001
	Casualty per Car Accident x Car per Accident	3520.937	4	880.234	2632.666	<0.001	0.010	1418.573	4	354.643	1817.137	<0.001	0.007
	Car per Accident x OSGR Easting Band	5.693	8	0.712	2.128	0.030	<0.001	9.833	8	1.229	6.298	<0.001	<0.001
	Car per Accident x OSGR Northing Band	19.262	12	1.605	4.801	<0.001	<0.001	28.640	12	2.387	12.229	<0.001	<0.001
	Car per Accident x Speed Limit Zone	291.454	10	29.145	87.170	<0.001	0.001	3992.690	10	399.269	2045.792	<0.001	0.019
	Casualty per Car Accident x OSGR Easting Band	55.044	8	6.881	20.579	<0.001	<0.001	1.630	8	0.204	1.044	0.400	<0.001
	Casualty per Car Accident x OSGR Northing Band	121.492	12	10.124	30.280	<0.001	<0.001	8.161	12	0.680	3.484	<0.001	<0.001
	Casualty per Car Accident x Speed Limit Zone	899.339	10	89.934	268.981	<0.001	0.003	698.582	10	69.858	357.942	<0.001	0.003
	OSGR Easting Band x OSGR Northing Band	12.493	24	0.521	1.557	0.040	<0.001	4.328	24	0.180	0.924	0.569	<0.001
	OSGR Easting Band x Speed Limit Zone	15.344	20	0.767	2.295	0.001	<0.001	11.475	20	0.574	2.940	<0.001	<0.001
	OSGR Northing Band x Speed Limit Zone	13.701	30	0.457	1.366	0.087	<0.001	13.671	30	0.456	2.335	<0.001	<0.001
Control	AccidentYear	2.014	1	2.014	6.025	0.014	<0.001	8.531	1	8.531	43.714	<0.001	<0.001
	Error	356085.111	1065004	0.334				207852.586	1065004	0.195			
	Total	4178017	1066287					4140252	1066287				
	Corrected Total	1445627.855	1066286					795956.304	1066286				
		*R^2 = 0.754 (Adjusted R^2 = 0.753)						*R^2 = 0.739 (Adjusted R^2 = 0.739)					
		Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)											

Generalised Linear Modelling of KSI Car Accidents and Findings

Three different model types such as counts, binary logistic, and ordinal logistic of GLM for KSI car accident counts, were developed depending on several discrete/ categorical factors.

GLM Poisson Model for the Casualty per KSI Car Accident

Poisson multiple models for the counts as the casualty per KSI car accident ($i.e.,\ y \geq 0,\ where,\ \bar{y} = 1.60 \geq s^2_{(y)} = 1.355$) with sample size, $n = 1066287$ based on two discrete explanatory factors and 13 categorical explanatory factors covering 1979-2015, applying GLM technique, was developed. Poisson multiple models were developed based on multiple explanatory factors such as accident year and speed limit as discrete factors; England region (8-dummies), lights conditions (4-dummies), road surface conditions (4-dummies), road type (4-dummies), and weather conditions (7-dummies) as nominal categorical factors; accident month (11-dummies), accident day (6-dummies), accident time (11-dummies), casualty per accident (2-dummies), car per accident (2-dummies), OSGR easting band (4-dummies), OSGR

northing band (6-dummies), and speed limit zone (5-dummies) as ordinal categorical factors; by fulfilling the assumptions. Reporting GLM Poisson model for the casualty per KSI car accident by discrete/ categorical factors is shown in Table 5.1.

Accident year as well as speed limit was statistically significant ($p \leq 0.05$) with unchanged likelihood [1]($i.e.,\ OR = 1$) of having outcomes. In England region, all dummies, (except, Eastern region, London region, and South-West region), were significant with greater likelihood ($i.e.,\ OR > 1$) of having outcomes. Only one dummy of lights conditions as 'darkness with lighting unknown' was significant with lesser likelihood ($i.e.,\ OR < 1$). Again, no dummies of road surface conditions were not statistically significant. Two dummies of road type as 'roundabout', and 'dual carriageway' were significant with lesser likelihood and greater likelihood respectively. In weather condition, only two dummies such as, 'snowing without high winds' and 'fog/ mist' were significant with lesser likelihood and greater likelihood respectively of having outcomes.

In accident month, March to September and December were significant with greater likelihood of having outcomes. In accident day, dummies (except Monday) were significant with greater likelihood on Sunday and Saturday, while Tuesday to Thursday were with lesser likelihood. Seven dummies of accident time, such as 1-2, 5-6, 7-8, 9-10, 13-14, 21-22, and 23-24 o'clock were significant with greater likelihood in 1-2 o'clock, 21-22 o'clock and 23-24 o'clock, while greater likelihood in remaining. Both dummies of car per accident such as single car and double cars were significant with lesser likelihood of having outcome; also, both dummies of casualty per accident such as single casualty and double casualties were significant with lesser likelihood. In OSGR easting, OSE 0-300km was significant with lesser likelihood, while OSE 500-600km and OSE 600-700km were significant with greater likelihood of having consequences. Again, only OSN 0-100km in OSGR northing was significant with greater likelihood. Also, two dummies of speed limit zone such as 20mph and 40mph were significant with greater likelihood and lesser likelihood respectively of having outcomes.

[1] **Odds Ratio**:

$OR = 1$: There are no higher or lower odds of the outcome happening.
$OR > 1$: There is a greater likelihood of having the outcome.
$OR < 1$: There is a lesser likelihood of having the outcome.

Table 5.1: GLM Poisson Model for the Casualty per KSI Car Accident

Reporting Generalised Linear Poisson Multiple Model for the Number of Casualty per KSI Car Accident in England											
	Parameter	Log(B)	Std. Error	95% Wald CI for Log(B)		Hypothesis Test			B	95% Wald CI for B	
				Lower	Upper	Wald Chi²	df	p-Value		Lower	Upper
	Intercept	1.456	0.0771	1.305	1.607	357.033	1	<0.001	4.289	3.688	4.989
	Accident Year	-0.000074	0.0000367	<-0.001	-0.00000216	4.076	1	0.043	1.000	1.000	1.000
	Speed Limit	0.002	0.0010	-0.0000084	0.004	3.808	1	0.050	1.002	1.000	1.004
England Region	North-East Region	0.013	0.0050	0.003	0.022	6.369	1	0.012	1.013	1.003	1.023
	North-West Region	0.010	0.0027	0.005	0.016	14.417	1	<0.001	1.010	1.005	1.016
	Yorkshire & the Humber Region	0.008	0.0027	0.002	0.013	7.585	1	0.006	1.008	1.002	1.013
	East Midlands Region	0.006	0.0023	0.002	0.011	7.178	1	0.007	1.006	1.002	1.011
	West Midlands Region	0.007	0.0021	0.003	0.011	12.414	1	<0.001	1.007	1.003	1.012
	Eastern Region	0.002	0.0023	-0.003	0.006	0.489	1	0.484	1.002	0.997	1.006
	London Region	0.001	0.0014	-0.001	0.004	0.920	1	0.337	1.001	0.999	1.004
	South-West Region	<0.001	0.0020	-0.004	0.004	0.009	1	0.924	1.000	0.996	1.004
	South-East Region **(Ref)**	0							1		
Lights Conditions	Darkness with Lights Lit	0.001	0.0012	-0.001	0.003	0.558	1	0.455	1.001	0.999	1.003
	Darkness with Lights Unlit	0.011	0.0063	-0.001	0.024	3.360	1	0.067	1.012	0.999	1.024
	Darkness without Lighting	-0.002	0.0017	-0.006	0.001	1.529	1	0.216	0.998	0.995	1.001
	Darkness with Lighting Unknown	-0.011	0.0030	-0.017	-0.005	13.530	1	<0.001	0.989	0.983	0.995
	Daylight **(Ref)**	0							1		
Road Surface Conditions	Wet or Damp	0.001	0.0010	-0.001	0.003	1.091	1	0.296	1.001	0.999	1.003
	Snow	0.004	0.0054	-0.007	0.014	0.496	1	0.481	1.004	0.993	1.014
	Frost or Ice	-0.003	0.0025	-0.008	0.001	1.874	1	0.171	0.997	0.992	1.001
	Flood over 3cm. Deep	0.014	0.0095	-0.005	0.032	2.027	1	0.155	1.014	0.995	1.033
	Dry **(Ref)**	0							1		
Road Type	Roundabout	-0.006	0.0014	-0.009	-0.004	20.836	1	<0.001	0.994	0.991	0.996
	Dual Carriageway	0.008	0.0012	0.006	0.010	43.701	1	<0.001	1.008	1.006	1.010
	One Way Street/ Slip Road	-0.001	0.0040	-0.009	0.006	0.130	1	0.718	0.999	0.991	1.006
	Unknown RT	0.006	0.0030	0.0000623	0.012	3.761	1	0.050	1.006	1	1.012
	Single Carriageway **(Ref)**	0							1		
Weather Conditions	Raining without High Winds	0.001	0.0013	-0.001	0.004	1.223	1	0.269	1.001	0.999	1.004
	Snowing without High Winds	-0.011	0.0049	-0.020	-0.001	4.991	1	0.025	0.989	0.980	0.999
	Fine with High Winds	0.001	0.0024	-0.003	0.006	0.310	1	0.578	1.001	0.997	1.006
	Raining with High Winds	0.003	0.0027	-0.002	0.009	1.314	1	0.252	1.003	0.998	1.009
	Snowing with High Winds	-0.011	0.0098	-0.030	0.008	1.328	1	0.249	0.989	0.970	1.008
	Fog or Mist	0.048	0.0090	0.031	0.066	28.822	1	<0.001	1.049	1.031	1.068
	Other/ Unknown WC	0.0000624	0.0020	-0.004	0.004	0.001	1	0.976	1.000	0.996	1.004
	Fine without High Winds **(Ref)**	0							1		
Accident Month	January	-0.002	0.0016	-0.005	0.001	1.120	1	0.290	0.998	0.995	1.001
	February	-0.002	0.0016	-0.005	0.001	1.378	1	0.240	0.998	0.995	1.001
	March	0.002	0.0017	-0.001	0.005	1.720	1	0.190	1.002	0.999	1.005
	April	0.005	0.0016	0.001	0.008	8.244	1	0.004	1.005	1.001	1.008
	May	0.006	0.0017	0.003	0.009	12.809	1	<0.001	1.006	1.003	1.009
	June	0.007	0.0018	0.003	0.010	14.222	1	<0.001	1.007	1.003	1.010
	July	0.009	0.0017	0.006	0.012	28.793	1	<0.001	1.009	1.006	1.013
	August	0.013	0.0018	0.010	0.017	59.002	1	<0.001	1.014	1.010	1.017
	September	0.007	0.0018	0.003	0.010	12.522	1	<0.001	1.007	1.003	1.010
	October	0.003	0.0016	<0.001	0.006	3.331	1	0.068	1.003	1.000	1.006
	December	0.003	0.0016	0.000073	0.006	4.020	1	0.045	1.003	1.000	1.006
	November **(Ref)**	0							1		
Accident Day	Sunday	0.018	0.0013	0.016	0.021	195.436	1	<0.001	1.018	1.016	1.021
	Monday	-0.002	0.0014	-0.004	0.001	1.432	1	0.231	0.998	0.996	1.001
	Tuesday	-0.005	0.0012	-0.008	-0.003	16.481	1	<0.001	0.995	0.993	0.997
	Wednesday	-0.007	0.0012	-0.010	-0.005	34.200	1	<0.001	0.993	0.990	0.995
	Thursday	-0.006	0.0012	-0.008	-0.004	23.349	1	<0.001	0.994	0.992	0.997
	Saturday	0.016	0.0012	0.014	0.019	169.807	1	<0.001	1.016	1.014	1.019
	Friday **(Ref)**	0							1		
Accident Time	AT(00:01-02:00)	0.005	0.0019	0.001	0.008	6.045	1	0.014	1.005	1.001	1.008
	AT(02:01-04:00)	0.004	0.0023	<0.001	0.009	3.501	1	0.061	1.004	1.000	1.009
	AT(04:01-06:00)	-0.010	0.0030	-0.016	-0.004	10.710	1	0.001	0.990	0.984	0.996
	AT(06:01-08:00)	-0.010	0.0018	-0.013	-0.006	29.190	1	<0.001	0.990	0.987	0.994
	AT(08:01-10:00)	-0.005	0.0017	-0.008	-0.002	9.732	1	0.002	0.995	0.992	0.998
	AT(10:01-12:00)	-0.001	0.0018	-0.005	0.002	0.371	1	0.543	0.999	0.995	1.002
	AT(12:01-14:00)	-0.003	0.0015	-0.006	<0.001	4.183	1	0.041	0.997	0.994	1.000
	AT(14:01-16:00)	0.002	0.0014	-0.001	0.005	2.019	1	0.155	1.002	0.999	1.005
	AT(18:01-20:00)	0.002	0.0013	-0.001	0.004	2.211	1	0.137	1.002	0.999	1.004
	AT(20:01-22:00)	0.009	0.0015	0.006	0.012	33.662	1	<0.001	1.009	1.006	1.012
	AT(22:01-00:00)	0.008	0.0015	0.005	0.011	24.929	1	<0.001	1.008	1.005	1.011
	AT(16:01-18:00) **(Ref)**	0							1		
Car per Accident	Single Car	-0.060	0.0014	-0.063	-0.058	1777.353	1	<0.001	0.941	0.939	0.944
	Double Cars	-0.047	0.0015	-0.050	-0.044	943.529	1	<0.001	0.954	0.952	0.957
	Multiple Cars **(Ref)**	0							1		
Casualty per Car Accident	Single Casualty	-1.333	0.0010	-1.335	-1.332	1945857.55	1	<0.001	0.264	0.263	0.264
	Double Casualties	-0.651	0.0010	-0.653	-0.649	450204.9	1	<0.001	0.521	0.520	0.522
	Multiple Casualties **(Ref)**	0							1		
OSGR Easting Band	OSE 0-300 km	-0.007	0.0023	-0.012	-0.003	10.484	1	0.001	0.993	0.988	0.997
	OSE 300-400 km	0.003	0.0016	<0.001	0.006	3.363	1	0.067	1.003	1.000	1.006
	OSE 500-600 km	0.003	0.0014	<0.001	0.006	4.976	1	0.026	1.003	1.000	1.006
	OSE 600-700 km	0.007	0.0023	0.003	0.012	9.378	1	0.002	1.007	1.003	1.012
	OSE 400-500 km **(Ref)**	0							1		
OSGR Northing Band	OSN 0-100 km	0.008	0.0020	0.004	0.012	14.512	1	<0.001	1.008	1.004	1.012
	OSN 200-300 km	-0.002	0.0018	-0.006	0.001	1.928	1	0.165	0.998	0.994	1.001
	OSN 300-400 km	0.001	0.0022	-0.003	0.006	0.431	1	0.511	1.001	0.997	1.006
	OSN 400-500 km	<0.001	0.0026	-0.005	0.005	0.003	1	0.959	1.000	0.995	1.005
	OSN 500-600 km	<0.001	0.0047	-0.009	0.009	0.001	1	0.980	1.000	0.991	1.009
	OSN 600+ km	0.001	0.0035	-0.006	0.008	0.037	1	0.847	1.001	0.994	1.008
	OSN 100-200 km **(Ref)**	0							1		
Speed Limit Zone	20 mph (32 km/h) Zone	0.026	0.0115	0.004	0.049	5.237	1	0.022	1.027	1.004	1.050
	40 mph (64 km/h) Zone	-0.020	0.0099	-0.039	-0.001	4.081	1	0.043	0.980	0.961	0.999
	50 mph (80 km/h) Zone	-0.034	0.0198	-0.072	0.005	2.887	1	0.089	0.967	0.930	1.005
	60 mph (96 km/h) Zone	-0.051	0.0295	-0.108	0.007	2.962	1	0.085	0.951	0.897	1.007
	70 mph (112 km/h) Zone	-0.047	0.0393	-0.124	0.030	1.449	1	0.229	0.954	0.883	1.030
	30 mph (48 km/h) Zone **(Ref)**	0							1		
	Scale based on the deviance	0.059									
	Number of Casualty per KSI Car Accident: Sample Size, n = 1066287, Mean = 1.60 and variance = 1.354896										
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)										

GLM Poisson Model for the Car per KSI Accident

Poisson model for the counts as the car per KSI accident ($i.e.,\ y \geq 0,\ where,\ \bar{y} = 1.77 \geq s^2_{(y)} = 0.746$) with sample size, $n = 1066287$ based on two discrete explanatory factors and 13 categorical explanatory factors covering 1979-2015, applying GLM technique, was developed. Poisson model was developed based on multiple explanatory factors as same as 6.1. Reporting GLM Poisson multiple models for the number of car per KSI car accident by discrete/ categorical factors is shown in Table 5.2.

Accident year was statistically significant ($p \leq 0.05$) with unchanged likelihood ($i.e.,\ OR = 1$) of having outcomes, but speed limit was not significant. In England region, Yorkshire & the Humber region as well as London region and South-West region were significant with greater and lesser likelihood ($i.e.,\ OR > 1$) of having outcomes respectively. 'Darkness with lights unlit' as well as 'darkness without lighting' in lights conditions was significant with lesser likelihood ($i.e.,\ OR < 1$). Again, no dummies of road surface conditions were not statistically significant. All dummies of road type, except roundabout, were significant with lesser likelihood in 'one way street/ slip road' and greater likelihood in 'dual carriageway' and 'unknown RT'. In weather condition, all dummies were significant with lesser likelihood in 'fine with high winds', and greater likelihood in remaining others of having outcomes.

In accident month, only July was significant with lesser likelihood of having outcomes. Sunday, Wednesday, and Saturday of accident day were significant with lesser likelihood. All dummies of accident time, except 13-14 o'clock and 15-16 o'clock, were statistically significant. Both dummies of car per accident (i.e., single car and double cars) were significant with lesser likelihood of having outcome; also, both dummies of casualty per accident (i.e., single casualty and double casualties) were significant with lesser likelihood. In OSGR easting, only OSE 300-400km was significant with greater likelihood of having consequences. Again, no dummies in OSGR northing was significant. Also in speed limit zone, only 40mph was significant with lesser likelihood of having outcomes.

Table 5.2: GLM Poisson Model for the Car per KSI Accident

Reporting Generalised Linear Poisson Multiple Model for the Number of Car per KSI Accident in England											
	Parameter	Log(B)	Std. Error	95% Wald CI for Log(B)		Hypothesis Test			B	95% Wald CI for B	
				Lower	Upper	Wald Chi^2	df	p-Value		Lower	Upper
	Intercept	0.714	0.0430	0.630	0.798	275.586	1	<0.001	2.042	1.877	2.222
	Accident Year	<0.001	0.0000207	<0.001	<0.001	146.186	1	<0.001	1.000	1.000	1.000
	Speed Limit	0.001	0.0005	<0.001	0.002	1.237	1	0.266	1.001	1.000	1.002
England Region	North-East Region	-0.002	0.0024	-0.007	0.002	0.873	1	0.350	0.998	0.993	1.002
	North-West Region	-0.001	0.0018	-0.004	0.003	0.084	1	0.772	0.999	0.996	1.003
	Yorkshire & the Humber Region	0.004	0.0018	<0.001	0.007	4.369	1	0.037	1.004	1.000	1.007
	East Midlands Region	0.001	0.0015	-0.002	0.004	0.155	1	0.694	1.001	0.998	1.004
	West Midlands Region	-0.001	0.0014	-0.004	0.002	0.515	1	0.473	0.999	0.996	1.002
	Eastern Region	-0.002	0.0013	-0.005	0.001	1.961	1	0.161	0.998	0.995	1.001
	London Region	-0.002	0.0010	-0.004	<0.001	5.708	1	0.017	0.998	0.996	1.000
	South-West Region	-0.004	0.0011	-0.006	-0.002	11.298	1	0.001	0.996	0.994	0.998
	South-East Region **(Ref)**	0	.	.	.	.	.	.	1	.	.
Lights Conditions	Darkness with Lights Lit	-0.0000796	0.0008	-0.002	0.002	0.009	1	0.925	1.000	0.998	1.002
	Darkness with Lights Unlit	-0.006	0.0020	-0.010	-0.002	8.419	1	0.004	0.994	0.990	0.998
	Darkness without Lighting	-0.003	0.0016	-0.006	-0.0000639	3.996	1	0.046	0.997	0.994	1.000
	Darkness with Lighting Unknown	-0.003	0.0016	-0.006	0.001	2.608	1	0.106	0.997	0.994	1.001
	Daylight **(Ref)**	0	.	.	.	.	.	.	1	.	.
Road Surface Conditions	Wet or Damp	0.001	0.0007	<0.001	0.002	2.294	1	0.130	1.001	1.000	1.002
	Snow	0.002	0.0047	-0.007	0.011	0.151	1	0.697	1.002	0.993	1.011
	Frost or Ice	0.002	0.0032	-0.004	0.008	0.411	1	0.522	1.002	0.996	1.008
	Flood over 3cm. Deep	0.003	0.0083	-0.013	0.020	0.175	1	0.676	1.003	0.987	1.020
	Dry **(Ref)**	0	.	.	.	.	.	.	1	.	.
Road Type	Roundabout	-0.001	0.0005	-0.002	<0.001	2.606	1	0.106	0.999	0.998	1.000
	Dual Carriageway	0.020	0.0007	0.019	0.022	776.737	1	<0.001	1.021	1.019	1.022
	One Way Street/ Slip Road	-0.005	0.0020	-0.009	-0.001	6.681	1	0.010	0.995	0.991	0.999
	Unknown RT	0.003	0.0016	0.000081	0.006	4.043	1	0.044	1.003	1.000	1.006
	Single Carriageway **(Ref)**	0	.	.	.	.	.	.	1	.	.
Weather Conditions	Raining without High Winds	0.005	0.0009	0.003	0.006	28.370	1	<0.001	1.005	1.003	1.006
	Snowing without High Winds	0.011	0.0044	0.002	0.020	6.303	1	0.012	1.011	1.002	1.020
	Fine with High Winds	-0.003	0.0011	-0.005	-0.001	6.957	1	0.008	0.997	0.995	0.999
	Raining with High Winds	0.004	0.0019	<0.001	0.008	4.704	1	0.030	1.004	1.000	1.008
	Snowing with High Winds	0.035	0.0108	0.014	0.056	10.514	1	0.001	1.036	1.014	1.058
	Fog or Mist	0.162	0.0155	0.131	0.192	109.150	1	<0.001	1.175	1.140	1.212
	Other/ Unknown WC	0.004	0.0016	0.001	0.007	6.961	1	0.008	1.004	1.001	1.007
	Fine without High Winds **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Month	January	0.002	0.0015	-0.001	0.005	2.100	1	0.147	1.002	0.999	1.005
	February	-0.001	0.0012	-0.003	0.002	0.208	1	0.648	0.999	0.997	1.002
	March	0.002	0.0014	-0.001	0.005	1.845	1	0.174	1.002	0.999	1.005
	April	-0.001	0.0010	-0.003	0.001	0.584	1	0.445	0.999	0.997	1.001
	May	-0.001	0.0010	-0.003	<0.001	2.274	1	0.132	0.999	0.997	1.000
	June	-0.002	0.0010	-0.004	0.0000863	3.521	1	0.061	0.998	0.996	1.000
	July	-0.002	0.0010	-0.004	<0.001	5.937	1	0.015	0.998	0.996	1.000
	August	-0.001	0.0010	-0.004	0.001	2.128	1	0.145	0.999	0.996	1.001
	September	-0.001	0.0011	-0.003	0.001	0.674	1	0.412	0.999	0.997	1.001
	October	-0.001	0.0009	-0.002	0.001	0.424	1	0.515	0.999	0.998	1.001
	December	0.001	0.0017	-0.002	0.005	0.755	1	0.385	1.001	0.998	1.005
	November **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Day	Sunday	-0.003	0.0009	-0.005	-0.001	11.284	1	0.001	0.997	0.995	0.999
	Monday	0.002	0.0012	<0.001	0.004	2.483	1	0.115	1.002	1.000	1.004
	Tuesday	-0.001	0.0008	-0.003	<0.001	2.445	1	0.118	0.999	0.997	1.000
	Wednesday	-0.002	0.0007	-0.003	<0.001	5.259	1	0.022	0.998	0.997	1.000
	Thursday	-0.001	0.0009	-0.002	0.001	0.368	1	0.544	0.999	0.998	1.001
	Saturday	-0.003	0.0007	-0.004	-0.001	12.625	1	<0.001	0.997	0.996	0.999
	Friday **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Time	AT(00:01-02:00)	-0.004	0.0011	-0.006	-0.002	11.843	1	0.001	0.996	0.994	0.998
	AT(02:01-04:00)	-0.003	0.0015	-0.006	<0.001	4.131	1	0.042	0.997	0.994	1.000
	AT(04:01-06:00)	-0.005	0.0018	-0.008	-0.001	7.646	1	0.006	0.995	0.992	0.999
	AT(06:01-08:00)	0.005	0.0017	0.002	0.008	8.489	1	0.004	1.005	1.002	1.009
	AT(08:01-10:00)	0.003	0.0011	0.001	0.005	7.840	1	0.005	1.003	1.001	1.005
	AT(10:01-12:00)	0.005	0.0016	0.002	0.008	8.538	1	0.003	1.005	1.002	1.008
	AT(12:01-14:00)	-0.001	0.0008	-0.003	<0.001	3.045	1	0.081	0.999	0.997	1.000
	AT(14:01-16:00)	-0.001	0.0007	-0.002	<0.001	1.864	1	0.172	0.999	0.998	1.000
	AT(18:01-20:00)	-0.001	0.0006	-0.003	<0.001	4.564	1	0.033	0.999	0.997	1.000
	AT(20:01-22:00)	-0.002	0.0009	-0.004	-0.001	7.999	1	0.005	0.998	0.996	0.999
	AT(22:01-00:00)	-0.002	0.0011	-0.004	<0.001	4.339	1	0.037	0.998	0.996	1.000
	AT(16:01-18:00) **(Ref)**	0	.	.	.	.	.	.	1	.	.
Car per Accident	Single Car	-1.207	0.0008	-1.208	-1.205	2026150.979	1	<0.001	0.299	0.299	0.300
	Double Cars	-0.516	0.0009	-0.517	-0.514	351127.291	1	<0.001	0.597	0.596	0.598
	Multiple Cars **(Ref)**	0	.	.	.	.	.	.	1	.	.
Casualty per Car Accident	Single Casualty	-0.031	0.0010	-0.033	-0.029	887.473	1	<0.001	0.970	0.968	0.971
	Double Casualties	-0.030	0.0012	-0.033	-0.028	635.959	1	<0.001	0.970	0.968	0.973
	Multiple Casualties **(Ref)**	0	.	.	.	.	.	.	1	.	.
OSGR Easting Band	OSE 0-300 km	<0.001	0.0011	-0.002	0.002	0.015	1	0.902	1.000	0.998	1.002
	OSE 300-400 km	0.003	0.0011	0.001	0.005	8.194	1	0.004	1.003	1.001	1.005
	OSE 500-600 km	<0.001	0.0009	-0.001	0.002	0.244	1	0.622	1.000	0.999	1.002
	OSE 600-700 km	0.003	0.0018	-0.001	0.006	2.739	1	0.098	1.003	0.999	1.007
	OSE 400-500 km **(Ref)**	0	.	.	.	.	.	.	1	.	.
OSGR Northing Band	OSN 0-100 km	0.002	0.0009	-0.0000403	0.003	3.665	1	0.056	1.002	1.000	1.003
	OSN 200-300 km	0.001	0.0010	-0.001	0.003	1.022	1	0.312	1.001	0.999	1.003
	OSN 300-400 km	-0.002	0.0013	-0.004	0.001	1.324	1	0.250	0.998	0.996	1.001
	OSN 400-500 km	-0.001	0.0016	-0.004	0.002	0.463	1	0.496	0.999	0.996	1.002
	OSN 500-600 km	-0.003	0.0023	-0.007	0.002	1.406	1	0.236	0.997	0.993	1.002
	OSN 600+ km	<0.001	0.0019	-0.004	0.003	0.053	1	0.818	1.000	0.996	1.003
	OSN 100-200 km **(Ref)**	0	.	.	.	.	.	.	1	.	.
Speed Limit Zone	20 mph (32 km/h) Zone	0.007	0.0058	-0.004	0.019	1.650	1	0.199	1.007	0.996	1.019
	40 mph (64 km/h) Zone	-0.013	0.0051	-0.023	-0.003	6.976	1	0.008	0.987	0.977	0.997
	50 mph (80 km/h) Zone	-0.014	0.0101	-0.034	0.006	1.924	1	0.165	0.986	0.967	1.006
	60 mph (96 km/h) Zone	-0.024	0.0151	-0.054	0.005	2.581	1	0.108	0.976	0.948	1.005
	70 mph (112 km/h) Zone	0.032	0.0202	-0.007	0.072	2.534	1	0.111	1.033	0.993	1.074
	30 mph (48 km/h) Zone **(Ref)**	0	.	.	.	.	.	.	1	.	.
	Scale based on the deviance	0.027									
	Number of Casualty per Accident: Sample Size, n = 1066287, Mean = 1.77 and variance = 0.746496										
	Black Mark: Highly Significant ($p < 0.001$); Blue Mark: Significant ($0.001 \leq p \leq 0.05$); Red Mark: not Significant ($p > 0.05$)										

GLM Binary Logistic Model for Junction-non-Junction details

Binary Logistic multiple models for the binary accident response applying GLM for KSI car accidents covering 1979-2015 with sample size ($n = 1066247$), was developed. A selected dichotomous/ binary variable naming junction-non-junction details, was used as binary responses (e.g., $y = 1$ if at/ within Junction accident and $y = 0$ if out of junction accident).

This binary logistic model was developed based on multiple explanatory factors as same as 6.1 by fulfilling the assumptions. Reporting GLM binary logistic model for the junction-non-junction details of KSI car accident by discrete/ categorical factors is shown in Table 5.3. Accident year as well as speed limit was statistically significant ($p \leq 0.05$) with lesser and greater likelihood of having the outcome respectively. In England region, North-East region as well as North-West region, Yorkshire & the Humber region, West Midlands region, and London region were significant with greater likelihood of having the consequences. All dummies of lights conditions, except 'darkness with lights unlit', were significant with lesser likelihood in 'darkness without lighting' but greater likelihood of having outcomes in 'darkness with lights lit', and 'darkness with lighting unknown'. All dummies of road surface condition were significant with lesser likelihood of having outcomes. Road type's all dummies were significant with greater likelihood, except 'unknown RT' with lesser likelihood of having outcomes. In dummies of weather conditions, raining without high winds, fine with high winds, snowing with high winds and other/ unknown WC were statistically significant, with greater likelihood of having consequences, except fine with high winds and snowing with high winds having lesser likelihood.

In ordinal factors, all dummies of accident month, except February and December, were statistically significant with lesser likelihood ($OR < 1$) of having the outcomes, except January that had greater likelihood ($OR > 1$). In accident day, all dummies, except Monday, were significant greater likelihood of having the consequences, except Sunday having lesser likelihood. Also, all dummies of accident time, except 15-16 o'clock, were significant with greater likelihood having the outcomes, except 9-10, 11-12 and 13-14 o'clock having lesser likelihood. Again, both dummies such as singe car and double cars of car per accident were statistically significant with lesser and greater likelihood of having outcomes respectively, while both dummies such as singe casualty and double casualties of casualty per accident were statistically significant with greater likelihood of having outcomes respectively. All dummies in OSGR easting were significant with lesser likelihood of having the outcomes in all dummies, except OSE 600-700km having greater likelihood; while only dummies of OSGR northing such as OSN 200-300km, OSN 300-400km, and OSN 500-600km were significant with lesser likelihood of having the consequences, except OSN 300-400km having greater likelihood. Also, all dummies of speed limit zone, except 20mph, were significant with lesser likelihood of having the outcomes.

Table 5.3: GLM Binary Logistic Model for Junction-non-Junction Details at KSI Car Accident

Reporting Generalised Linear Binary Logistic Multiple Model for the Junction-non-Junction Details at KSI Car Accidents in England											
	Parameter	Logit(B)	Std. Error	95% Wald CI for Logit(B)		Hypothesis Test			B	95% Wald CI for B	
				Lower	Upper	Wald Chi^2	df	p-Value		Lower	Upper
	Intercept	7.790	0.5810	6.651	8.928	179.770	1	<0.001	2415.367	773.493	7542.403
	Accident Year	-0.004	0.0002	-0.005	-0.004	355.240	1	<0.001	0.996	0.995	0.996
	Speed Limit	0.027	0.0131	0.001	0.052	4.189	1	0.041	1.027	1.001	1.054
England Region	North-East Region	0.291	0.0245	0.243	0.339	140.616	1	<0.001	1.338	1.275	1.404
	North-West Region	0.244	0.0167	0.212	0.277	213.479	1	<0.001	1.277	1.236	1.320
	Yorkshire & the Humber Region	0.119	0.0166	0.087	0.152	51.846	1	<0.001	1.127	1.091	1.164
	East Midlands Region	0.025	0.0139	-0.003	0.052	3.140	1	0.076	1.025	0.997	1.053
	West Midlands Region	0.086	0.0127	0.061	0.111	45.954	1	<0.001	1.090	1.063	1.118
	Eastern Region	-0.010	0.0121	-0.034	0.014	0.650	1	0.420	0.990	0.967	1.014
	London Region	0.367	0.0092	0.349	0.385	1582.129	1	<0.001	1.443	1.417	1.469
	South-West Region	0.023	0.0124	-0.001	0.047	3.477	1	0.062	1.023	0.999	1.048
	South-East Region **(Ref)**	0	.	.	.	.	.	.	1	.	.
Lights Conditions	Darkness with Lights Lit	0.294	0.0082	0.278	0.310	1305.001	1	<0.001	1.342	1.321	1.364
	Darkness with Lights Unlit	0.016	0.0282	-0.039	0.072	0.332	1	0.565	1.016	0.962	1.074
	Darkness without Lighting	-0.364	0.0107	-0.385	-0.343	1147.351	1	<0.001	0.695	0.680	0.710
	Darkness with Lighting Unknown	0.105	0.0248	0.056	0.154	17.854	1	<0.001	1.111	1.058	1.166
	Daylight **(Ref)**	0	.	.	.	.	.	.	1	.	.
Road Surface Conditions	Wet or Damp	-0.167	0.0062	-0.179	-0.154	719.266	1	<0.001	0.847	0.836	0.857
	Snow	-0.899	0.0368	-0.971	-0.827	596.185	1	<0.001	0.407	0.379	0.438
	Frost or Ice	-0.878	0.0181	-0.913	-0.842	2346.022	1	<0.001	0.416	0.401	0.431
	Flood over 3cm. Deep	-1.152	0.0693	-1.288	-1.016	276.064	1	<0.001	0.316	0.276	0.362
	Dry **(Ref)**	0	.	.	.	.	.	.	1	.	.
Road Type	Roundabout	5.472	0.0868	5.302	5.642	3976.333	1	<0.001	237.848	200.650	281.942
	Dual Carriageway	0.154	0.0082	0.138	0.171	356.911	1	<0.001	1.167	1.149	1.186
	One Way Street/ Slip Road	0.556	0.0378	0.482	0.630	215.932	1	<0.001	1.744	1.619	1.878
	Unknown RT	-0.238	0.0223	-0.281	-0.194	113.948	1	<0.001	0.789	0.755	0.824
	Single Carriageway **(Ref)**	0	.	.	.	.	.	.	1	.	.
Weather Conditions	Raining without High Winds	0.063	0.0080	0.047	0.078	60.655	1	<0.001	1.065	1.048	1.081
	Snowing without High Winds	0.063	0.0362	-0.008	0.134	3.069	1	0.080	1.065	0.992	1.144
	Fine with High Winds	-0.065	0.0167	-0.098	-0.033	15.357	1	<0.001	0.937	0.907	0.968
	Raining with High Winds	0.006	0.0189	-0.031	0.043	0.101	1	0.750	1.006	0.969	1.044
	Snowing with High Winds	-0.259	0.0664	-0.390	-0.129	15.280	1	<0.001	0.771	0.677	0.879
	Fog or Mist	0.023	0.0243	-0.025	0.070	0.886	1	0.346	1.023	0.976	1.073
	Other/ Unknown WC	-0.035	0.0126	-0.060	-0.010	7.682	1	0.006	0.966	0.942	0.990
	Fine without High Winds **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Month	January	0.026	0.0105	0.005	0.046	6.118	1	0.013	1.026	1.005	1.047
	February	-0.018	0.0107	-0.039	0.003	2.755	1	0.097	0.982	0.962	1.003
	March	-0.028	0.0105	-0.048	-0.007	7.056	1	0.008	0.972	0.953	0.993
	April	-0.078	0.0108	-0.099	-0.057	52.307	1	<0.001	0.925	0.906	0.945
	May	-0.070	0.0106	-0.091	-0.049	43.022	1	<0.001	0.933	0.913	0.952
	June	-0.064	0.0107	-0.085	-0.043	35.226	1	<0.001	0.938	0.919	0.958
	July	-0.093	0.0107	-0.114	-0.072	76.109	1	<0.001	0.911	0.892	0.930
	August	-0.100	0.0106	-0.121	-0.080	88.862	1	<0.001	0.904	0.886	0.924
	September	-0.066	0.0104	-0.087	-0.046	40.152	1	<0.001	0.936	0.917	0.955
	October	-0.028	0.0100	-0.047	-0.008	7.660	1	0.006	0.973	0.954	0.992
	December	0.015	0.0102	-0.005	0.035	2.139	1	0.144	1.015	0.995	1.035
	November **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Day	Sunday	-0.072	0.0080	-0.088	-0.057	81.991	1	<0.001	0.930	0.916	0.945
	Monday	0.010	0.0079	-0.005	0.025	1.653	1	0.198	1.010	0.995	1.026
	Tuesday	0.033	0.0079	0.017	0.048	17.272	1	<0.001	1.033	1.017	1.049
	Wednesday	0.034	0.0078	0.019	0.049	18.866	1	<0.001	1.035	1.019	1.050
	Thursday	0.037	0.0077	0.022	0.052	23.140	1	<0.001	1.038	1.022	1.053
	Saturday	-0.055	0.0076	-0.070	-0.040	52.313	1	<0.001	0.947	0.933	0.961
	Friday **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Time	AT(00:01-02:00)	-0.445	0.0134	-0.471	-0.419	1109.715	1	<0.001	0.641	0.624	0.658
	AT(02:01-04:00)	-0.467	0.0170	-0.501	-0.434	759.848	1	<0.001	0.627	0.606	0.648
	AT(04:01-06:00)	-0.418	0.0209	-0.459	-0.377	399.828	1	<0.001	0.658	0.632	0.686
	AT(06:01-08:00)	-0.037	0.0109	-0.059	-0.016	11.756	1	0.001	0.963	0.943	0.984
	AT(08:01-10:00)	0.106	0.0090	0.089	0.124	138.552	1	<0.001	1.112	1.093	1.132
	AT(10:01-12:00)	0.131	0.0094	0.112	0.149	193.711	1	<0.001	1.140	1.119	1.161
	AT(12:01-14:00)	0.098	0.0087	0.081	0.115	126.354	1	<0.001	1.103	1.084	1.122
	AT(14:01-16:00)	-0.014	0.0082	-0.030	0.002	2.926	1	0.087	0.986	0.970	1.002
	AT(18:01-20:00)	-0.048	0.0081	-0.064	-0.032	35.389	1	<0.001	0.953	0.938	0.968
	AT(20:01-22:00)	-0.140	0.0098	-0.159	-0.121	205.871	1	<0.001	0.869	0.853	0.886
	AT(22:01-00:00)	-0.295	0.0106	-0.316	-0.275	779.875	1	<0.001	0.744	0.729	0.760
	AT(16:01-18:00) **(Ref)**	0	.	.	.	.	.	.	1	.	.
Car per Accident	Single Car	-0.416	0.0077	-0.431	-0.400	2879.823	1	<0.001	0.660	0.650	0.670
	Double Cars	0.565	0.0073	0.550	0.579	6028.121	1	<0.001	1.759	1.734	1.784
	Multiple Cars **(Ref)**	0	.	.	.	.	.	.	1	.	.
Casualty per Car Accident	Single Casualty	0.161	0.0067	0.148	0.175	575.381	1	<0.001	1.175	1.160	1.191
	Double Casualties	0.091	0.0076	0.077	0.106	145.997	1	<0.001	1.096	1.080	1.112
	Multiple Casualties **(Ref)**	0	.	.	.	.	.	.	1	.	.
OSGR Easting Band	OSE 0-300 km	-0.080	0.0154	-0.110	-0.049	26.779	1	<0.001	0.923	0.896	0.952
	OSE 300-400 km	-0.021	0.0098	-0.040	-0.001	4.399	1	0.036	0.980	0.961	0.999
	OSE 500-600 km	-0.038	0.0083	-0.054	-0.022	21.008	1	<0.001	0.963	0.947	0.979
	OSE 600-700 km	0.129	0.0142	0.102	0.157	83.478	1	<0.001	1.138	1.107	1.170
	OSE 400-500 km **(Ref)**	0	.	.	.	.	.	.	1	.	.
OSGR Northing Band	OSN 0-100 km	0.014	0.0136	-0.013	0.040	1.012	1	0.314	1.014	0.987	1.041
	OSN 200-300 km	-0.024	0.0101	-0.044	-0.004	5.571	1	0.018	0.976	0.957	0.996
	OSN 300-400 km	0.048	0.0128	0.023	0.074	14.342	1	<0.001	1.050	1.024	1.076
	OSN 400-500 km	-0.005	0.0157	-0.035	0.026	0.093	1	0.761	0.995	0.965	1.026
	OSN 500-600 km	-0.168	0.0225	-0.212	-0.124	56.084	1	<0.001	0.845	0.809	0.883
	OSN 600+ km	-0.033	0.0229	-0.078	0.012	2.084	1	0.149	0.967	0.925	1.012
	OSN 100-200 km **(Ref)**	0	.	.	.	.	.	.	1	.	.
Speed Limit Zone	20 mph (32 km/h) Zone	0.005	0.1451	-0.279	0.289	0.001	1	0.972	1.005	0.756	1.336
	40 mph (64 km/h) Zone	-0.687	0.1312	-0.944	-0.430	27.416	1	<0.001	0.503	0.389	0.651
	50 mph (80 km/h) Zone	-1.525	0.2624	-2.039	-1.011	33.788	1	<0.001	0.218	0.130	0.364
	60 mph (96 km/h) Zone	-1.986	0.3929	-2.757	-1.216	25.558	1	<0.001	0.137	0.064	0.296
	70 mph (112 km/h) Zone	-2.739	0.5240	-3.766	-1.712	27.332	1	<0.001	0.065	0.023	0.180
	30 mph (48 km/h) Zone **(Ref)**	0	.	.	.	.	.	.	1	.	.
	Scale based on the deviance	1.187									
	Sample Size (n)	1066247									
	Black Mark: Highly Significant (p < 0.001); Blue Mark: Significant (0.001 ≤ p ≤ 0.05); Red Mark: not Significant (p > 0.05)										

GLM Ordinal Logistic Model for First Numbered Road Zone

Ordinal Logistic multiple models for the first numbered road zone ordinal response applying GLM technique for KSI car accidents covering 1979-2015 with sample size, $n = 777311$, was developed. First numbered road zone as ordinal variable was used as ordinal response (e.g., $y = 0$ if zone-1 as reference, $y = 1$ if zone-2, $y = 2$ if zone-3, $y = 3$ if zone-4, $y = 4$ if zone-5, and $y = 5$ if zone-6). This ordinal logistic model was developed based on multiple explanatory factors (15-factors) same as 5.4 model by fulfilling the assumptions.

All thresholds (except, zone 2) as intercepts were statistically significant with greater likelihood of having the consequences. Due to common factors for each threshold, all explanatory dummies are detailed. Accident year as well as speed limit was significant ($p \leq 0.05$) with greater and lesser likelihood respectively. All dummies in England region were significant with greater likelihood of having the outcomes. In lights condition, all dummies, except 'darkness with lighting unknown', were significant with greater likelihood, except darkness with lights unlit having lesser likelihood. Wet/ damp as well as frost/ ice in road surface condition was also significant with greater likelihood. Again, in road type, one way street/ slip road as well as unknown road type was significant with greater and lesser likelihood respectively. Again, all dummies of weather conditions, except 'snowing without high winds' as well as 'snowing with high winds', were statistically significant.

No dummies of accident month, as well as accident day were statistically significant, while a few dummies of accident time such as 3-4 o'clock, 5-6 o'clock, 7-8 o'clock, 9-10 o'clock, 19-20 o'clock and 23-24 o'clock, were significant with greater likelihood in 3-4 o'clock and 5-6 o'clock and lesser likelihood of having outcomes in remaining. Again, both dummies such as single car and double cars of car per accident were statistically significant with greater and lesser likelihood of having outcomes respectively, while only single casualty dummy of casualty per accident was statistically significant with greater likelihood of having outcomes. All dummies in OSGR easting were significant with lesser likelihood of having the outcomes; while all dummies in OSGR northing, except OSN 0-100km, were significant with greater likelihood of having the consequences. Also in speed limit zone, all dummies, except 20mph, had statistically significance with greater likelihood.

Table 5.4: GLM Ordinal Logistic Model for First Numbered Road Zone at KSI Car Accident

Reporting Generalised Linear Binary Logistic Multiple Model for the First Numbered Road Zone at KSI Car Accidents in England

	Parameter	Logit(B)	Std. Error	95% Wald CI for Logit(B)		Hypothesis Test			B	95% Wald CI for B	
				Lower	Upper	Wald Chi²	df	p-Value		Lower	Upper
Threshold	First Numbered Road Zone-2	0.795	0.5021	-0.189	1.779	2.508	1	0.113	2.215	0.828	5.926
	First Numbered Road Zone-3	2.193	0.5021	1.209	3.177	19.071	1	<0.001	8.961	3.349	23.977
	First Numbered Road Zone-4	3.625	0.5022	2.641	4.609	52.107	1	<0.001	37.531	14.025	100.429
	First Numbered Road Zone-5	4.624	0.5022	3.640	5.609	84.774	1	<0.001	101.930	38.089	272.780
	First Numbered Road Zone-6	5.753	0.5023	4.768	6.737	131.162	1	<0.001	314.998	117.694	843.064
	First Numbered Road Zone-1 **(Ref)**	0	.	.	.	.	.	.	1	.	.
	Accident Year	0.001	0.0002	0.001	0.001	30.650	1	<0.001	1.001	1.001	1.001
	Speed Limit	-0.028	0.0118	-0.051	-0.005	5.603	1	0.018	0.972	0.950	0.995
England Region	North-East Region	3.190	0.0225	3.146	3.234	20085.041	1	<0.001	24.282	23.234	25.377
	North-West Region	1.693	0.0147	1.664	1.722	13226.480	1	<0.001	5.437	5.283	5.597
	Yorkshire & the Humber Region	2.690	0.0150	2.661	2.720	32029.892	1	<0.001	14.739	14.311	15.179
	East Midlands Region	2.300	0.0136	2.273	2.326	28598.453	1	<0.001	9.970	9.708	10.239
	West Midlands Region	1.017	0.0114	0.994	1.039	7989.591	1	<0.001	2.764	2.703	2.826
	Eastern Region	4.769	0.0177	4.735	4.804	72416.274	1	<0.001	117.834	113.811	121.999
	London Region	1.836	0.0137	1.809	1.863	17987.560	1	<0.001	6.271	6.105	6.442
	South-West Region	0.916	0.0083	0.900	0.933	12062.586	1	<0.001	2.500	2.460	2.541
	South-East Region **(Ref)**	0	.	.	.	.	.	.	1	.	.
Lights Conditions	Darkness with Lights Lit	0.019	0.0070	0.006	0.033	7.609	1	0.006	1.019	1.006	1.033
	Darkness with Lights Unlit	-0.147	0.0229	-0.192	-0.102	41.232	1	<0.001	0.863	0.825	0.903
	Darkness without Lighting	0.018	0.0079	0.002	0.033	4.908	1	0.027	1.018	1.002	1.034
	Darkness with Lighting Unknown	0.018	0.0213	-0.024	0.059	0.679	1	0.410	1.018	0.976	1.061
	Daylight **(Ref)**	0	.	.	.	.	.	.	1	.	.
Road Surface Conditions	Wet or Damp	0.012	0.0051	0.002	0.022	5.450	1	0.020	1.012	1.002	1.022
	Snow	0.042	0.0312	-0.019	0.103	1.824	1	0.177	1.043	0.981	1.109
	Frost or Ice	0.054	0.0142	0.026	0.082	14.262	1	<0.001	1.055	1.026	1.085
	Flood over 3cm. Deep	0.044	0.0384	-0.031	0.119	1.325	1	0.250	1.045	0.969	1.127
	Dry **(Ref)**	0	.	.	.	.	.	.	1	.	.
Road Type	Roundabout	-0.001	0.0095	-0.020	0.017	0.015	1	0.903	0.999	0.980	1.018
	Dual Carriageway	-0.001	0.0058	-0.012	0.010	0.026	1	0.872	0.999	0.988	1.010
	One Way Street/ Slip Road	0.064	0.0303	0.004	0.123	4.440	1	0.035	1.066	1.004	1.131
	Unknown RT	-0.705	0.0428	-0.789	-0.621	271.900	1	<0.001	0.494	0.454	0.537
	Single Carriageway **(Ref)**	0	.	.	.	.	.	.	1	.	.
Weather Conditions	Raining without High Winds	-0.031	0.0065	-0.043	-0.018	22.187	1	<0.001	0.970	0.958	0.982
	Snowing without High Winds	-0.021	0.0294	-0.079	0.036	0.526	1	0.468	0.979	0.924	1.037
	Fine with High Winds	0.060	0.0138	0.033	0.087	18.567	1	<0.001	1.061	1.033	1.091
	Raining with High Winds	-0.037	0.0139	-0.065	-0.010	7.179	1	0.007	0.963	0.937	0.990
	Snowing with High Winds	-0.003	0.0436	-0.088	0.083	0.004	1	0.949	0.997	0.916	1.086
	Fog or Mist	0.040	0.0178	0.005	0.075	5.027	1	0.025	1.041	1.005	1.078
	Other/ Unknown WC	-0.116	0.0124	-0.140	-0.091	87.627	1	<0.001	0.891	0.869	0.913
	Fine without High Winds **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Month	January	-0.002	0.0088	-0.020	0.015	0.069	1	0.793	0.998	0.981	1.015
	February	-0.003	0.0091	-0.020	0.015	0.082	1	0.774	0.997	0.980	1.015
	March	0.003	0.0090	-0.014	0.021	0.138	1	0.710	1.003	0.986	1.021
	April	0.006	0.0093	-0.012	0.024	0.410	1	0.522	1.006	0.988	1.024
	May	0.005	0.0092	-0.013	0.023	0.278	1	0.598	1.005	0.987	1.023
	June	0.004	0.0093	-0.014	0.023	0.221	1	0.638	1.004	0.986	1.023
	July	0.010	0.0092	-0.008	0.028	1.168	1	0.280	1.010	0.992	1.028
	August	0.009	0.0091	-0.009	0.027	1.041	1	0.308	1.009	0.992	1.027
	September	0.005	0.0089	-0.013	0.022	0.283	1	0.595	1.005	0.987	1.022
	October	0.008	0.0085	-0.009	0.025	0.924	1	0.336	1.008	0.992	1.025
	December	-0.004	0.0085	-0.021	0.013	0.223	1	0.637	0.996	0.980	1.013
	November **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Day	Sunday	0.007	0.0068	-0.007	0.020	0.979	1	0.323	1.007	0.993	1.020
	Monday	0.003	0.0068	-0.010	0.017	0.252	1	0.616	1.003	0.990	1.017
	Tuesday	-0.001	0.0068	-0.015	0.012	0.032	1	0.858	0.999	0.986	1.012
	Wednesday	0.006	0.0068	-0.007	0.019	0.789	1	0.374	1.006	0.993	1.019
	Thursday	0.002	0.0066	-0.011	0.015	0.124	1	0.725	1.002	0.989	1.015
	Saturday	0.001	0.0065	-0.012	0.014	0.018	1	0.893	1.001	0.988	1.014
	Friday **(Ref)**	0	.	.	.	.	.	.	1	.	.
Accident Time	AT(00:01-02:00)	-0.005	0.0109	-0.026	0.017	0.184	1	0.668	0.995	0.974	1.017
	AT(02:01-04:00)	0.026	0.0136	0.000	0.053	3.759	1	0.050	1.027	1.000	1.054
	AT(04:01-06:00)	0.033	0.0167	0.000	0.066	3.865	1	0.049	1.033	1.000	1.068
	AT(06:01-08:00)	-0.025	0.0092	-0.043	-0.007	7.197	1	0.007	0.976	0.958	0.993
	AT(08:01-10:00)	-0.022	0.0080	-0.038	-0.007	7.748	1	0.005	0.978	0.963	0.993
	AT(10:01-12:00)	-0.002	0.0081	-0.018	0.014	0.063	1	0.802	0.998	0.982	1.014
	AT(12:01-14:00)	0.011	0.0076	-0.004	0.026	2.018	1	0.155	1.011	0.996	1.026
	AT(14:01-16:00)	0.002	0.0072	-0.013	0.016	0.047	1	0.828	1.002	0.987	1.016
	AT(18:01-20:00)	-0.015	0.0071	-0.029	-0.001	4.423	1	0.035	0.985	0.972	0.999
	AT(20:01-22:00)	-0.012	0.0082	-0.028	0.005	1.965	1	0.161	0.989	0.973	1.005
	AT(22:01-00:00)	-0.024	0.0088	-0.041	-0.007	7.673	1	0.006	0.976	0.959	0.993
	AT(16:01-18:00) **(Ref)**	0	.	.	.	.	.	.	1	.	.
Car per Accident	Single Car	0.017	0.0064	0.005	0.030	7.386	1	0.007	1.017	1.005	1.030
	Double Cars	-0.021	0.0058	-0.032	-0.009	12.995	1	<0.001	0.979	0.968	0.991
	Multiple Cars **(Ref)**	0	.	.	.	.	.	.	1	.	.
Casualty per Car Accident	Single Casualty	0.010	0.0052	0.000	0.020	3.709	1	0.054	1.010	1.000	1.021
	Double Casualties	-0.010	0.0058	-0.021	0.002	2.846	1	0.092	0.990	0.979	1.002
	Multiple Casualties **(Ref)**	0	.	.	.	.	.	.	1	.	.
OSGR Easting Band	OSE 0-300 km	-0.558	0.0112	-0.580	-0.536	2475.080	1	<0.001	0.572	0.560	0.585
	OSE 300-400 km	-0.165	0.0062	-0.178	-0.153	715.469	1	<0.001	0.848	0.837	0.858
	OSE 500-600 km	-0.639	0.0104	-0.659	-0.618	3804.309	1	<0.001	0.528	0.517	0.539
	OSE 600-700 km	-0.710	0.0172	-0.744	-0.677	1710.195	1	<0.001	0.491	0.475	0.508
	OSE 400-500 km **(Ref)**	0	.	.	.	.	.	.	1	.	.
OSGR Northing Band	OSN 0-100 km	<0.001	0.0093	-0.019	0.018	0.003	1	0.958	1.000	0.981	1.018
	OSN 200-300 km	0.896	0.0105	0.875	0.916	7292.683	1	<0.001	2.450	2.400	2.500
	OSN 300-400 km	1.480	0.0138	1.453	1.507	11470.095	1	<0.001	4.392	4.275	4.512
	OSN 400-500 km	1.786	0.0153	1.756	1.816	13587.383	1	<0.001	5.968	5.792	6.150
	OSN 500-600 km	1.665	0.0205	1.625	1.705	6594.609	1	<0.001	5.285	5.076	5.501
	OSN 600+ km	0.744	0.0277	0.689	0.798	719.162	1	<0.001	2.104	1.992	2.221
	OSN 100-200 km **(Ref)**	0	.	.	.	.	.	.	1	.	.
Speed Limit Zone	20 mph (32 km/h) Zone	-0.241	0.1488	-0.532	0.051	2.619	1	0.106	0.786	0.587	1.052
	40 mph (64 km/h) Zone	0.231	0.1185	-0.001	0.463	3.794	1	0.050	1.260	0.999	1.589
	50 mph (80 km/h) Zone	0.688	0.2369	0.224	1.152	8.431	1	0.004	1.989	1.251	3.165
	60 mph (96 km/h) Zone	0.870	0.3552	0.174	1.566	6.005	1	0.014	2.388	1.190	4.789
	70 mph (112 km/h) Zone	1.492	0.4736	0.563	2.420	9.921	1	0.002	4.444	1.757	11.244
	30 mph (48 km/h) Zone **(Ref)**	0	.	.	.	.	.	.	1	.	.
	Scale based on the deviance	0.592									
	Sample Size (n)	777311									

Black Mark: Highly Significant ($p < 0.001$); Blue Mark: Significant ($0.001 \leq p \leq 0.05$); Red Mark: not Significant ($p > 0.05$)

Research Findings, Discussions, Conclusion and Recommendations

The road KSI car accidents fall steadily from 1979 through 2015 in England, although these have sudden increases and decreases during time tenure. By following research aims/ questions, the findings based on discrete, dichotomous, nominal, and ordinal factors in road KSI car accidents, are briefed and discussed. The lowest KSI car accidents occurred in 2014.

All the multiple models confirm that there is a statistically decrease in KSI car accident for each extra accident year.

In the Poisson model for the casualty per KSI car accident:

- Accident year as well as speed limit was statistically significant with unchanged likelihood of having outcomes.
- In England region, all dummies, (except, Eastern region, London region, and South-West region), were significant with greater likelihood.
- Only one dummy of lights conditions as 'darkness with lighting unknown' was significant with lesser likelihood.
- No dummies of road surface conditions were not statistically significant.
- Two dummies of road type as 'roundabout', and 'dual carriageway' were significant with lesser likelihood and greater likelihood respectively.
- In weather condition, only two dummies, 'snowing without high winds' and 'fog/ mist', were significant with lesser likelihood and greater likelihood respectively.
- In accident month, March through September and December were significant with greater likelihood.
- In accident day, all dummies (except, Monday) were significant with greater likelihood on Sunday and Saturday, while Tuesday to Thursday were with lesser likelihood.
- Seven dummies of accident time, such as 1-2, 5-6, 7-8, 9-10, 13-14, 21-22, and 23-24 o'clock were significant with greater likelihood, while greater likelihood in remaining.
- Both dummies of car per accident, single car, and double cars, were significant with lesser likelihood.
- Both dummies of casualty per accident, single casualty, and double casualties, were significant with lesser likelihood.
- In OSGR easting, OSE 0-300km was significant with lesser likelihood, while OSE 500-600km and OSE 600-700km were significant with greater likelihood.
- Only OSN 0-100km in OSGR northing was significant with greater likelihood.
- Two dummies of speed limit zone, 20mph and 40mph, were significant with greater likelihood and lesser likelihood respectively of having outcomes.

In the Poisson model for the car per KSI accident:

- Accident year was statistically significant with unchanged likelihood of having outcomes, but speed limit was not significant.
- In England region, Yorkshire & the Humber region as well as London region and South-West region were significant.
- 'Darkness with lights unlit' as well as 'darkness without lighting' in lights conditions was significant with lesser likelihood.
- No dummies of road surface conditions were not statistically significant.
- All dummies of road type, except roundabout, were significant with lesser likelihood in 'one way street/ slip road' and greater likelihood in 'dual carriageway' and 'unknown RT'.
- In weather condition, all dummies were significant with lesser likelihood in 'fine with high winds', and greater likelihood in remaining others.

- In accident month, only July was significant with lesser likelihood.
- Sunday, Wednesday, and Saturday of accident day were significant with lesser likelihood.
- All dummies of accident time, except 13-14 o'clock and 15-16 o'clock, were statistically significant.
- Both dummies of car per accident, single car, and double cars, were significant with lesser likelihood.
- Both dummies of casualty per accident, single casualty, and double casualties, were significant with lesser likelihood.
- In OSGR easting, only OSE 300-400km was significant with greater likelihood.
- No dummies in OSGR northing were significant.
- In speed limit zone, only 40mph was significant with lesser likelihood of having outcomes.

In the Binary Logistic model for junction-non-junction details:

- Accident year as well as speed limit was statistically significant with lesser and greater likelihood respectively.
- In England region, North-East region as well as North-West region, Yorkshire & the Humber region, West Midlands region, and London region were significant with greater likelihood.
- All dummies of lights conditions (except 'darkness with lights unlit') were significant with lesser likelihood in 'darkness without lighting' but greater likelihood in 'darkness with lights lit', and 'darkness with lighting unknown'.
- All dummies of road surface condition were significant with lesser likelihood.
- Road type's all dummies were significant with greater likelihood, except 'unknown RT' with lesser likelihood.
- In dummies of weather conditions, 'raining without high winds', 'fine with high winds', 'snowing with high winds', and 'other/ unknown WC' were statistically significant, with greater likelihood, except fine with high winds and snowing with high winds having lesser likelihood.
- All dummies of accident month, except February and December, were statistically significant with lesser likelihood, except January having greater likelihood.
- In accident day, all dummies (except Monday) were significant with greater likelihood, except Sunday having lesser likelihood.
- Also, all dummies of accident time, except 15-16 o'clock, were significant with greater likelihood; except 9-10, 11-12 and 13-14 o'clock having lesser likelihood.
- Both dummies, single car, and double cars of car per accident, were statistically significant with lesser and greater likelihood respectively.
- Both dummies, single casualty, and double casualties of casualty per accident, were significant with greater likelihood respectively.
- In OSGR easting, there were significant with lesser likelihood in all dummies, except OSE 600-700km having greater likelihood.

- Only dummies of OSGR northing such as OSN 200-300km, OSN 300-400km, and OSN 500-600km were significant with lesser likelihood, except OSN 300-400km having greater likelihood.
- All dummies of speed limit zone, except 20mph, were significant with lesser likelihood.

In the Ordinal Logistic model for first numbered road zone:

- All thresholds (except, zone-2) as intercepts were statistically significant with greater likelihood referenced by zone-1.
- Accident year as well as speed limit was significant with greater and lesser likelihood respectively.
- All dummies in England region were significant with greater likelihood.
- In lights condition, all dummies (except 'darkness with lighting unknown') were significant with greater likelihood, except darkness with lights unlit having lesser likelihood.
- 'Wet/ damp' as well as 'frost/ ice' in road surface condition was also significant with greater likelihood.
- In road type, 'one way street/ slip road' as well as 'unknown road type' was significant with greater and lesser likelihood respectively.
- All dummies of weather conditions (except 'snowing without high winds' and 'snowing with high winds') were statistically significant.
- No dummies of accident month, as well as accident day were statistically significant, while a few dummies of accident time such as 3-4 o'clock, 5-6 o'clock, 7-8 o'clock, 9-10 o'clock, 19-20 o'clock and 23-24 o'clock, were significant with greater likelihood in 3-4 o'clock and 5-6 o'clock and lesser likelihood of having outcomes in remaining.
- Both dummies, 'single car' and 'double cars' of car per accident, were statistically significant with greater and lesser likelihood respectively.
- Only 'single casualty' dummy of casualty per accident was statistically significant with greater likelihood.
- All dummies in OSGR easting were significant with lesser likelihood.
- All dummies in OSGR northing (except OSN 0-100km) were significant with greater likelihood of having the consequences.
- In speed limit zone, all dummies (except 20mph) had statistically significance with greater likelihood.

The findings have significant implications for the understanding of how to best reduce road car accidents. Overall, this study strengthens the idea that it is to helpful for the policymakers to decide how to reduce the KSI car accidents and associated cars leading to zero-vision.

This research study contains a few limitations. The main limitation is that it is based on only one source of secondary data, i.e., STATS19 database run by UK Police and DfT. Based on the data making up part of a long running time series going back to 1926, the research study has used the datasets going back to 1979 to provide a long period comparison. The data used to the research study are collected by police forces, either through police officers attending the scene of accidents or from members of the public reporting the accident in police stations after the incident. It does not have any obligation for people to report all personal-injury accidents to the police, although there is an obligation under certain conditioned, as outlined in the Road

Act. For this reason, STATS19 data do not represent the full range of all road accidents or casualties or both in England/ Great Britain.

One of the strengths of this study is that it includes most factors contained in STATS19 database with large sample covering the period 1979-2015. The key factors that are statistically significant for KSI car accidents, are identified. The strengths of the study included the in-depth analysis followed by modelling of KSI car accidents. Study on road accident analysis/ modelling for reducing KSI accidents is very important.

This research leads a key policy priority that should therefore be to plan for the long-term prevention of road car accidents. The identified significant factors leading KSI car accidents, can be taken special attention so that KSI car accidents can be reduced. The findings of this study have several important implications for future practice.

The recommendations can be summarised as follows:

a) There is a need to include 'roads policing'.
b) There is a need for 'Police and Crime Commissioners' to prioritise roads policing and road safety within 'Police and Crime Plans'.
c) There is a need to increase the number of roads policing officers.
d) There is a need to enlarge the Collaboration and partnerships.
e) There is a need to enhance the 'Intelligence' as well as to share more widely.
f) There is a need to enhance 'the Research and Evaluation'.

This is an important issue for future research. There are still many unanswered questions about road car accidents. This research has thrown up many questions in need of further investigation. Future studies on the current topic are therefore recommended. Further studies need to be carried out in order to validate the current study. This work would be based on case studies and involve psychologists, sociologists, and statisticians. These findings are dynamic if policymakers are to be able to identify those individuals at greatest threat of KSI car accident involvement. Policies to reduce the KSI car accidents can then be effectively implemented. Until such policies are implemented, KSI car accidents and associated casualties will remain unnecessarily high for certain individuals in the society, and as a society people will all suffer. Where there is an alert today, there is an alive tomorrow. Stay Alive – Think and Drive.

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