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Road Accident Scenario: A Spatio-Temporal Analysis of Chhattisgarh State, India

Soumen Mondal[1], Baburam Mandal[2]
[1,2] Research scholar, S.o.S. in Geography, Pt. Ravi Shankar Shukla University, Raipur, Chhattisgarh

ABSTRACT: This paper has been carried out the road accident of district wise in Chhattisgarh State, India. The main analysis of this paper is spatio - temporal distribution of road accidents, death, and injured person by vehicles in the state according to month, diurnal, different types of vehicles, roads, and area wise. January is the most accidental, death, and injured month during the year 2018-2020. The diurnal variation of road accidents shown at evening to night time from 6-9 PM is the maximum. At the evening time the most of people have faced low visibility problems and the mainly in cold winter season. The paper has been Analysis of vehicles wise, the two-wheeler is the highest road accident then four-wheelers shows at because maximum people traveling from one place to another place through this vehicles. According to the road, wise, rural, and district roads have been maximum shows in various districts of the Chhattisgarh state. The rural area indicates more accidents as compared to the urban area because 76.76% of people live in the rural area. Road accidents are increasing day by day due to the high growth rate of the population with the rapid increase of registered motor vehicles but road density and road space have not increased. The district wise accident severity indexes have been shown the maximum cases in Kondagaon, Jashpur district, and the high accident risk district in Raipur. Raipur, Bilaspur, and Durg district shows the maximum road accident in the state. All over India faced COVID-19 pandemic situation from March 2020 and shows the minimum road accident and deaths but an injured person is increased. The government urgently takes appropriate action and needs to improve road safety for this worsening situation.

KEYWORDS: Road Accident Cases, Registered Vehicles, Spatio-Temporal Variation.

INTRODUCTION

Chhattisgarh is major undergoing urbanization and motorization. Transport facilities are adequate and improved in Chhattisgarh state as well as India over the years. Day by day the population growth of the state is very high, but public transport systems are not sufficient for people in terms of quantity and quality. For this reason, the use of personal vehicles such as two-wheelers, three-wheelers, four-wheelers, etc. registered rapidly. Today in urban areas roads and footpaths are encroached by street hawkers, illegal parking, etc. forcing all pedestrians to walk on the road. As a result pedestrian life is very risky when they walk on the road and slow movement of traffic. The increasing number of registered vehicles increased road accidents which become a serious threat to our society. But we are always neglected all-time in our busy life. We create this man-made disaster that affects society. In the world, approximately 1.3 million peoples die every year from road traffic crashes (WHO, 2021). India registered the highest road accident in the world with 1.5 lakh people has been killed and more than 3.5 lakh crippled annually. According to Nitin Gadkari, (Minister of Road Transport and Highways, Govt. of India) road accident scenario is more serious than covid-19 of 415 death per day, and 70% of deaths are working age group between 18-45 years (The Economics Times, 2021). The accident is suddenly an unwanted incident which is not only affected the victims; it is also affecting their whole family and their financial condition. Road accidents are interrelated by various factors like the high growth rate of population, increased of registered vehicles, length of the road, rush driving and traffic rules violation, etc. (Uniyal and Agarwal, 2019). The different types of road accidents as a result injured, fatality, death, partial disability, etc.

The increasing number of road traffic accidents is a challenging issue over the whole transportation system. It is not only a health issue; it is also associated with economic development in society (Kumari and Sharma, 2019). It is much difficult to identify the cause of road accidents and is an important task for safety analysis. So preventive action can be taken and reduced the severity of road accidents in Chhattisgarh state in the future.

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STUDY AREA

The newly formed Chhattisgarh state was divided from previously Madhya Pradesh in the year 2000 and it is located in central India. The total area covers of the state are 135192 Sq.km. which is a geographical area of 4.11% and the 9th largest state in India. The geographical location of the state is 170 47' N to 240 06' N latitude and 800 15' E to 840 24' E longitude. It has been five divisions and 27 districts. The two-lane and four-lane roads are connected all over the major city and pass 11 National Highways through the state (3078 Km). The State Highways and major district roads cover 8031 Km. The road density is much below the national average. The capital of the state is Raipur. The annual average rainfall is 1400 mm, which is 90% confined in the monsoon season and annual range of temperature 11o to 47o C (CGWRD, 2019). East Deccan physiographic zone falls under the state and it is divided into three agro-climatic zones. The biggest river of the Chhattisgarh is Mahanadi, which is also known as the lifeline of the state. AS per as 2011 Census, 25.55 million people are lived, which is 23.24% urban population and 76.76% rural population. The average density of population is 189 per sq. km.

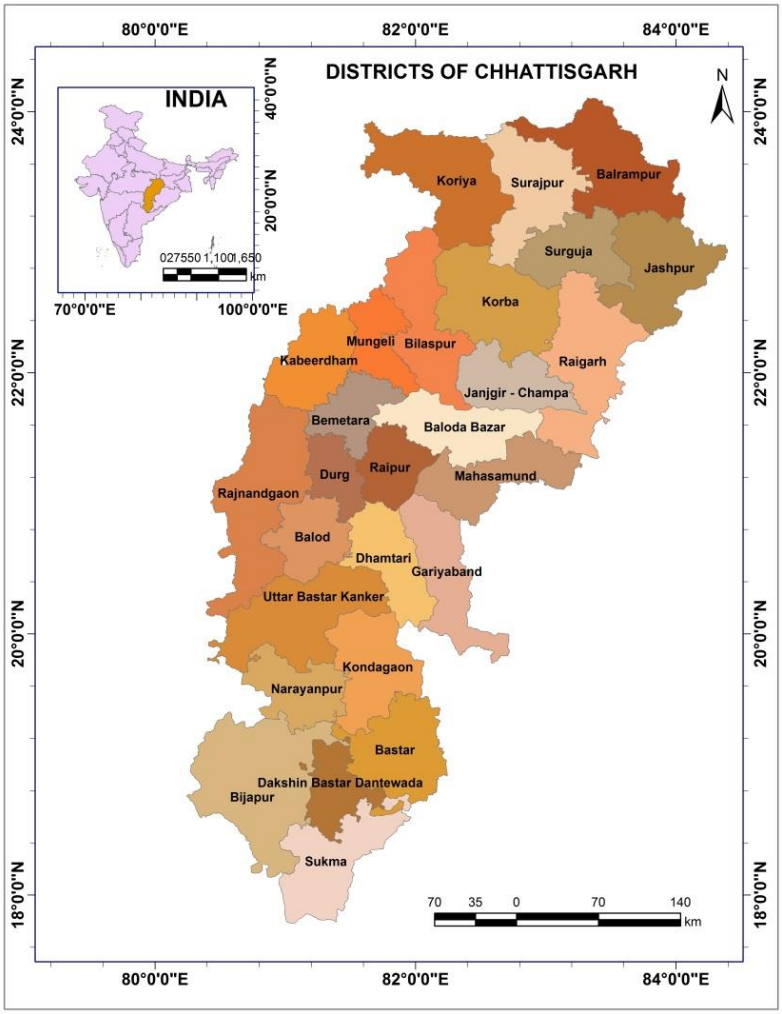

Fig. No. 1. Location map of Chhattisgarh State

OBJECTIVES

1. To analyze the Spatio-temporal road accident and death in the Chhattisgarh state.
2. To examine the accident severity index and accident risk in the study area.

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DATABASE AND METHODOLOGY

The entire study is based on a secondary source of data. The main sources of secondary data are published and unpublished data collected from Police Head Quarters, Government of Chhattisgarh and Ministry of Road Transport and Highways, Government of India. To evaluate the Spatio-temporal changes in the number of road accidents, injured peoples, and deaths have been calculated. The trends of a road accident, injured and death has been analyzed from the period of 2001-2020 and the district wise has been analyzed from 2017 to 2020 of the study area. Arc GIS software has been also used for variation among road accidents during the different years of the Chhattisgarh state. To shows more details of road accident month-wise, diurnal variation, category-wise vehicles, road-wise, and area-wise road accident has been analyzed from the period of 2018-2020 and reason of road accident in the year 2020. The Accident Severity Index (ASI) and Accident Risk (AR) are calculated which have been given below:

1. Accident Severity Index:

$$ASI = PK/TA \times 100$$

Where,
PK = Number of Person Killed
TA = Total Number of Road Accidents

2. Accident Risk:

$$AR = TA/P \times 100000$$

Where,
TA = Total Number of Road Accidents
P = Total population

3. Accident Fatality Risk (AFR)

$$AFR = PK/P \times 100000$$

Where,
PK = Total Number of Death
P = Total Population

RESULT AND DISCUSSION

ROAD ACCIDENT SCENARIO

Over the past years of India, there has been an alarming increase in road accidents, injured people, and deaths. India is one of the highest motorized growth rate countries in the world which is accompanied by the rapid growth of Urbanization and rapid expansion of road network after independence, but our country is seriously faced with road safety levels (NCRB, 2016). According to the Ministry of Road Transport and Highways (2019), the scenario of a road traffic accident in India, Tamilnadu rank 1st (57228) and Chhattisgarh rank 11th (14366), but in case of death by road accident, Uttar Pradesh is the highest position (23285) and Chhattisgarh rank 14th (5003) position out of the all states and Union territories. Day by day Chhattisgarh state has been registered rapidly increasing of a road accident cases, death and injured person is presented in the table number 1 and Figure number 2.

Table No. 1. : Trend of Road Accident in Chhattisgarh state

Years	Total Accidents	Person Death	Person Injured
2001	7480	1303	6674
2002	8485	1673	7718
2003	9913	1881	8732
2004	10600	2060	9897
2005	11164	2258	10308
2006	11934	2364	11208
2007	12296	2607	11735
2008	12945	2966	12873

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2009	12888	2865	13274
2010	13664	2956	13599
2011	14108	2983	13929
2012	13511	3167	13517
2013	13657	3477	12503
2014	13821	4022	13157
2015	14446	4082	13427
2016	13580	3908	12955
2017	13563	4136	12550
2018	13864	4592	12715
2019	13899	5003	13090
2020	11656	4606	10505

Source: Police Head Quarters, Govt. of Chhattisgarh

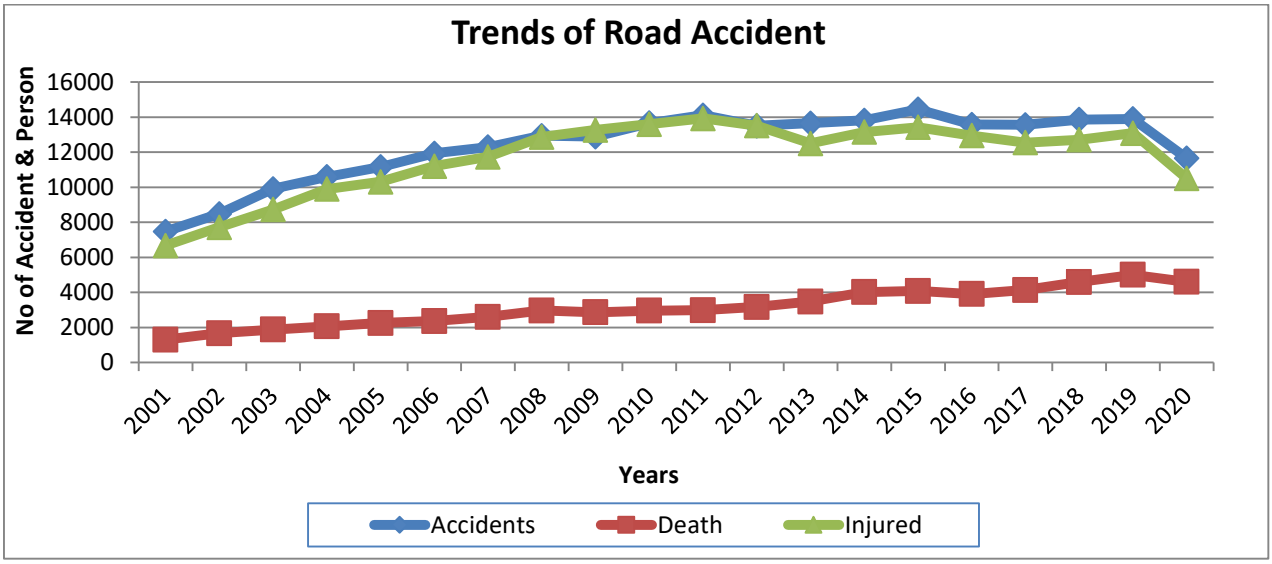

Fig. No.2. Trends of Road Accident (2001-2020).

The road accident cases have increased 64.17% over the last twenty years, 7480 total cases in 2001 to 11656 in 2020. The 14446 number of road accident cases have been registered in 2015 and 7480 in 2020. The last five years data has been shows that the numbers of road accident cases have been decrease as compared to 2015 and 2011. In the year 2020, the registered road accident cases are 11656, which are shown a decrease over the last 14 years (20106-2019). The average road accident cases in the last two decades are 12373 and the average numbers of deaths are 3145. The average injured people are 11718, which are more than the year 2020. Table number 1 has been shows that the maximum depths are 5003 in 2019 and the minimum are 1303 in the last two decades. The road accident deaths have increased 282.19% and injured is increased 63.58% in the last twenty years (fig. 1). The maximum number of registered persons injured is 13929 in 2011. In the last decades, the minimum injured person is 10505 in 2020. During the Covid-19 pandemic period the lockdown rules has been implements all over the nation and minimize the numbers of peoples for travelled purpose. Few of them have were travelled for return to home, due to those reason the total number of road accident cases and injured persons have been decreasing. In these abnormal situation the accident cases has been changed. The table number 2 is showing the year wise total Accident, Deaths, and Accident Severity Index.

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Table No. 2: Total Accident, Deaths, and Accident Severity Index

Districts	2017			2018			2019			2020		
	TA	DT	ASI	TA	DT	ASI	TA	DT	ASI	TA	DT	ASI
Raipur	2159	420	19.45	2075	427	20.58	2146	458	21.34	1766	482	27.29
Baloda-Bazar	592	210	35.47	686	246	35.86	677	261	38.55	588	212	36.05
Mahasamund	501	208	41.52	450	205	45.55	502	223	44.42	427	219	51.29
Gariyaband	254	75	29.53	297	78	26.26	266	89	33.46	255	102	40.00
Dhamtari	372	125	33.60	347	133	38.33	317	131	41.32	309	145	46.93
Durg	1106	251	22.69	1006	218	21.67	883	213	24.12	898	197	21.94
Bemetara	319	122	38.24	355	136	38.31	372	161	43.28	388	182	46.90
Balod	322	114	35.40	342	144	42.10	412	167	40.53	335	124	37.01
Rajnandgaon	840	219	26.07	905	287	31.71	960	316	32.92	816	306	37.50
Kabirdham	286	75	26.22	343	134	39.07	314	119	37.90	285	96	33.68
Bilaspur	1125	233	20.71	1363	325	23.84	1292	388	30.03	1002	344	34.33
Mungeli	249	69	27.71	268	85	31.72	293	87	29.69	258	96	37.21
Korba	715	241	33.71	670	191	28.51	688	239	34.73	496	221	44.55
Jangir-Champa	641	240	37.44	706	286	40.51	668	304	45.50	529	211	39.89
Raigarh	680	245	36.02	656	261	39.79	640	281	43.91	487	252	51.74
Sarguja	387	172	44.44	401	186	46.38	379	177	46.70	273	136	49.81
Koriya	373	125	33.51	350	116	33.14	355	133	37.46	322	128	39.75
Balrampur	309	116	37.54	341	187	54.84	337	156	46.29	259	146	56.37
Surajpur	376	166	44.15	356	172	48.31	381	211	55.38	307	178	57.98
Jashpur	370	188	50.81	330	180	54.55	386	220	56.99	246	154	62.60
Jagdalpur	422	119	28.20	468	149	31.84	524	205	39.12	442	168	39.81
Kanker	453	132	29.14	408	167	40.93	351	173	49.29	322	176	54.66
Kondagaon	224	123	54.91	269	138	51.30	265	128	48.30	205	127	61.95
Dantewada	180	74	41.11	131	48	36.64	110	50	45.45	86	56	65.11
Sukma	75	22	29.33	70	30	42.86	87	42	48.27	85	54	63.53
Narayanpur	93	15	16.13	101	30	29.70	99	33	33.33	85	39	45.88
Bijapur	140	37	26.43	170	33	19.41	195	38	19.49	185	55	29.73

TA = Total Accidents, DT = Deaths and ASI = Accident Severity Index

SPATIO- TEMPORAL VARIATION OF ROAD ACCIDENT

The table number has been 2 shows the Spatio-temporal analysis of the total accident, total deaths, and calculated the accident severity index. In the year 2017, the maximum registered road accident district is Raipur (2159), Bilaspur (1125), Durg (1106) and the minimum registered is Sukma (75), Narayanpur (93) Bijapur (140). In the year 2018, the maximum road accident district is Raipur (2075), Bilaspur (1363), Durg (1006) and the minimum is Sukma (70), Narayanpur (101), Dantewada (131). As compared to the previous three years, 2020 represents the minimum number of road accidents. Which maximum shows is Raipur (1766) and the minimum is Narayanpur (39), Sukma (54), Bijapur (55), Dantewada (56). The above table number 2 is shows that 2017 indicates maximum road accident cases during 2017-2020 and the 2020 indicates minimum road accidents cases. The average road accident in Chhattisgarh State is 491 during the year 2017-2020. The average maximum road accident is 515 in 2019 and the minimum is 432 in 2020.

The number of deaths is maximum in Raipur district (420) and minimum in Narayanpur (15), Sukma (22), Bijapur (37) in the year 2017. Similarly in 2018 maximum number of registered deaths is Raipur (427) and the minimum is Sukma (70), Narayanpur (101). In the year 2019 Raipur district shows maximum deaths (458) and the minimum is Narayanpur (33), Bijapur (38), Sukma (42), Dantewada (50). As compared to the last four years, the average maximum death (185) in 2019 and minimum (153) in 2017.

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The maximum number of deaths in 2018 is Raipur (482) and the minimum is Narayanpur (39). The average death during (2017-2020) is 170.

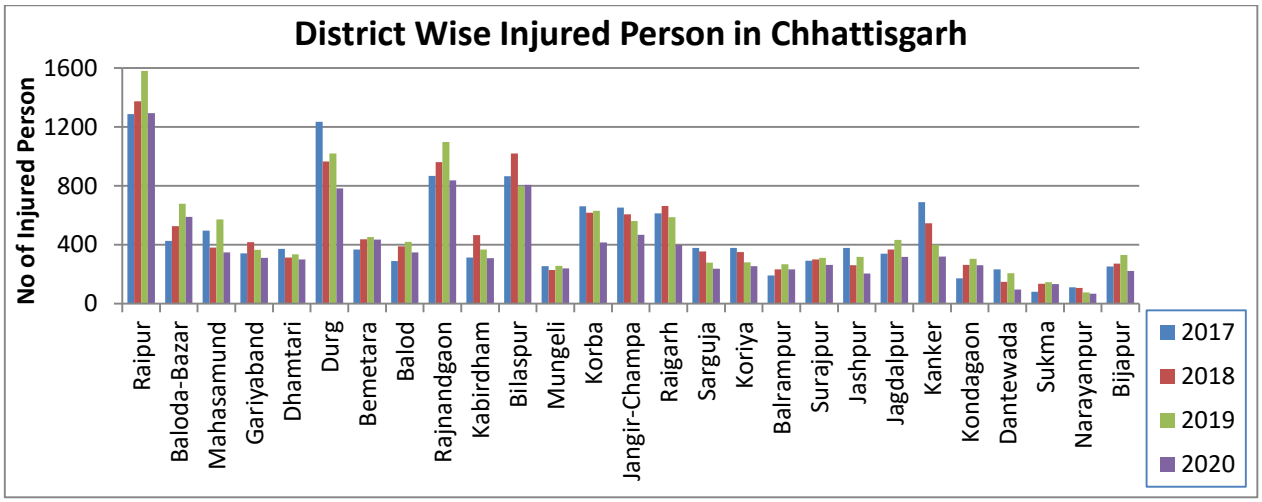

Fig. No. 3. District Wise Injured Person in Chhattisgarh

The above mentioned fig. number 3 shows that 2017 has been registered the maximum number of injured persons due to road accidents in the different districts in Chhattisgarh State and the year 2020 has been registered minimum number of injured persons. During the year 2017-2020, Raipur, Durg, Rajnandgaon, Bilaspur has been registered the maximum number of injured persons and the minimum number registered district in Narayanpur, Sukma, Dantewada, Bijapur, Kondagaon, Mungeli, Balrampur.

ACCIDENT SEVERITY INDEX IN CHHATTISGARH (2017-2020)

The accident severity index has been shown seriousness by accident and it is defined as the number of person death per 100 accidents. The district of accident severity index is maximum in Kondagaon (54.91), Jashpur (50.81), and minimum in Narayanpur (16.13), Raipur (19.45), Bilaspur (20.71) in 2017. Table 1.2 shows that the maximum severity index is Balarampur (54.84), Jashpur (54.55), Kondagaon (51.30) and the minimum is Bijapur (19.41), Raipur (20.58), Durg (21.67) in 2018. In the year 2019, the maximum accident severity index is Jashpur (56.99), Surajpur (55.38) and the minimum is Bijapur (19.49), Raipur (21.34). The district has shown maximum accident severity index is Datewada (65.11), Sukma (63.53), Jashpur (62.60), Kondagaon (61.95) and the minimum is Durg (21.94), Raipur (27.29), Bijapur (29.73). During the year 2017-2020, the minimum accident severity index is Bijapur, Raipur and the maximum is Jashpur, Kondagaon.

Table No. 3: district wise total accident and accident risk in Chhattisgarh State

Districts	2017		2018		2019		2020	
	TA	AR	TA	AR	TA	AR	TA	AR
Raipur	2159	79.00	2075	73.01	2146	72.62	1766	57.46
Baloda-Bazar	592	35.58	686	39.59	677	37.52	588	31.30
Mahasamund	501	30.11	450	25.97	502	27.82	427	22.73
Gariyaband	254	38.63	297	44.42	266	39.18	255	36.97
Dhamtari	372	43.18	347	39.78	317	35.90	309	34.56
Durg	1106	59.19	1006	53.11	883	45.99	898	46.14
Bemetara	319	32.39	355	34.79	372	35.18	388	35.42
Balod	322	36.76	342	38.66	412	46.13	335	37.14
Rajnandgaon	840	49.05	905	51.89	960	54.07	816	45.14

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Kabirdham	286	28.34	343	32.85	314	29.07	285	25.50
Bilaspur	1125	48.89	1363	57.62	1292	53.13	1002	40.08
Mungeli	249	28.97	268	30.21	293	31.98	258	27.26
Korba	715	53.62	670	49.39	688	49.85	496	35.32
Jangir-Champa	641	34.91	706	37.66	668	34.91	529	27.09
Raigarh	680	41.74	656	39.62	640	38.03	487	28.48
Sarguja	387	42.25	401	43.08	379	40.07	273	28.40
Koriya	373	52.55	350	48.72	355	48.83	322	43.76
Balrampur	309	37.55	341	40.62	337	39.35	259	29.65
Surajpur	376	42.82	356	39.83	381	41.87	307	33.14
Jashpur	370	40.01	330	35.20	386	40.61	246	25.53
Jagdalpur	422	46.07	468	50.28	524	55.39	442	45.98
Kanker	453	56.25	408	49.97	351	42.40	322	38.36
Kondagaon	224	35.35	269	41.77	265	40.50	205	30.83
Dantewada	180	58.79	131	42.20	110	34.95	86	26.95
Sukma	75	28.25	70	26.13	87	32.18	85	31.14
Narayanpur	93	58.95	101	62.85	99	60.48	85	50.98
Bijapur	140	51.54	170	62.00	195	70.47	185	66.25

TA = Total Accident, AR = Accident Risk

ACCIDENT RISK IN CHHATTISGARH STATE (2017-2020)

The table number 3 is shows the accident risk in a different district in Chhattisgarh state in a different period (2017-2020). The accident risk is defined as the total number of accidents per 100000 populations in a particular year. Fig. shows the trends of risk during 2017-2020. The accident risk range is very high (79.00), and very low (22.73). The all districts of Chhattisgarh state has been divided into three categories based on accident risk i.e. low accident risk (<30), medium accident risk (30-60), high accident risk (>60).

LOW ACCIDENT RISK (<30)

In 2017 only three districts Kabordham, Mungeli, Sukma have been shows low accident risk. The two districts Mahasamund and Sukma have been found in 2018. In the year 2020 nine districts Mahasamund. Kabirdham, Mungeli, Jangir-Champa, Raigarh, Sarguja, Jaipur, Dantewada, and Mahasamund, Kabirdham in 2019 have been come under this category.

MEDIUM ACCIDENT RISK (30-60)

The medium accident risk shows in 23 and 22 districts in the years 2017 and 2018 respectively. In 2019 there are 22 districts and in 2020 there are 17 districts that fall under this medium accident risk. This zone of risk represents the maximum districts of the Chhattisgarh state.

HIGH ACCIDENT RISK (>60)

In the years 2017 and 2020 only one district is Raipur and Bijapur shows high accident risk. The three districts in 2018 and 2019 are Raipur, Narayanpur, Bijapur have been shown under a high accident risk. All over the high accident risk zone Raipur district is common in the years 2017, 2018, 2019.

ACCIDENT FATALITY RISK IN CHHATTISGARH (2017-2020)

The accident fatality risk has been analysis during the last four years from 2017-2020. The fatality risk is defined as the total number of road accidental deaths per 100000 populations in a particular year. Table shows that the fatality risks range from high (24.17) to low (7.43). Chhattisgarh state are divided into three categories on the basis of fatality risk i.e. Low Fatality Risk (< 10), Medium Fatality Risk (10-20) and High Fatality Risk (> 20). The table number 4 is presented the Accident fatality risk in chhattisgarh state.

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Table No. 4. Districts wise Accident fatality risk in chhattisgarh state.

Districts	2017		2018		2019		2020	
	DT	FR	DT	FR	DT	FR	DT	FR
Raipur	420	15.37	427	15.02	458	15.49	482	15.68
Baloda-Bazar	210	12.62	246	14.20	261	14.47	212	11.28
Mahasamund	208	12.50	205	11.83	223	12.36	219	11.66
Gariyaband	75	11.40	78	11.67	89	13.11	102	14.79
Dhamtari	125	14.51	133	15.25	131	14.83	145	16.22
Durg	251	13.43	218	11.51	213	11.09	197	10.12
Bemetara	122	12.39	136	13.33	161	15.23	182	16.61
Balod	114	13.01	144	16.28	167	18.70	124	13.75
Rajnandgaon	219	12.79	287	16.46	316	17.80	306	16.93
Kabirdham	75	7.43	134	12.84	119	11.01	96	8.59
Bilaspur	233	10.13	325	13.74	388	15.95	344	13.76
Mungeli	69	8.03	85	9.58	87	9.50	96	10.14
Korba	241	18.07	191	13.60	239	17.31	221	15.74
Jangir-Champa	240	13.07	286	15.26	304	15.89	211	10.80
Raigarh	245	15.04	261	15.76	281	16.70	252	14.74
Sarguja	172	18.78	186	19.98	177	18.71	136	14.15
Koriya	125	17.61	116	16.15	133	18.29	128	17.40
Balrampur	116	14.09	187	22.28	156	18.22	146	16.71
Surajpur	166	18.90	172	19.24	211	23.19	178	19.22
Jashpur	188	20.33	180	19.20	220	23.14	154	15.98
Jagdalpur	119	12.99	149	16.00	205	21.67	168	17.48
Kanker	132	16.39	167	20.45	173	20.90	176	20.97
Kondagaon	123	19.41	138	21.43	128	19.56	127	19.10
Dantewada	74	24.17	48	15.46	50	15.88	56	17.55
Sukma	22	8.29	30	11.20	42	15.53	54	19.79
Narayanpur	15	9.51	30	18.67	33	20.16	39	23.39
Bijapur	37	13.62	33	12.04	38	13.73	55	19.69

MONTH AND DIURNAL VARIATION OF ROAD ACCIDENT, DEATHS AND INJURED PERSON

The Table number 5 and the Figure number 4 have been show the monthly distribution of road accidents in Chhattisgarh. However monthly and yearly variation of road accidents is not an equal. The month of January shows the maximum number of road accident cases in the year 2018-2020. In the year 2020 minimum road accident cases shows in April, May, and July month as compared to 2018-2019. The month of December, January, February, March, and May shows maximum death in the year 2018. Fig. shows the maximum death in 2019 in January, May, and June. In the year 2020 the maximum death cases have been shows in November, December, January, and February but this year indicates the minimum deaths among the previous three years. The month of April and September shows minimum deaths. The injured person is maximum among the three years in January month as compare to others months, but in the year 2020 December month registered maximum injured person in the state. The month of September is always registered the minimum number of injured persons. During the COVID-19 pandemic situation road accident and their deaths is minimum in 2020 because the entire country including the world faced lockdown but the injured person has been increased. The maximum number of accidents, deaths, and injured has been registered in December and January because of extreme in normal condition due to the weather conditions all over Chhattisgarh.

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Table no. 5. Month Wise Road Accident, Deaths and Injured

Month	Accident			Death			Injured		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
January	1476	1385	1375	503	519	453	1269	1310	1423
February	1205	1241	1262	395	442	492	1159	1223	1212
March	1207	1115	957	402	391	389	1115	1001	914
April	1160	1233	286	355	435	128	1199	1331	228
May	1154	1259	699	418	495	290	1143	1225	600
June	1128	1187	917	386	495	390	1002	1175	769
July	1154	1166	690	377	419	400	1020	1086	829
August	1076	1033	908	343	328	351	1031	969	772
September	1019	996	864	293	310	363	895	899	737
October	1109	1097	1049	359	383	400	1015	983	865
November	1069	1123	1198	355	408	470	914	1000	1048
December	1107	1064	1181	406	378	480	953	908	1108

Source: Police Head Quarters, Govt. of Chhattisgarh

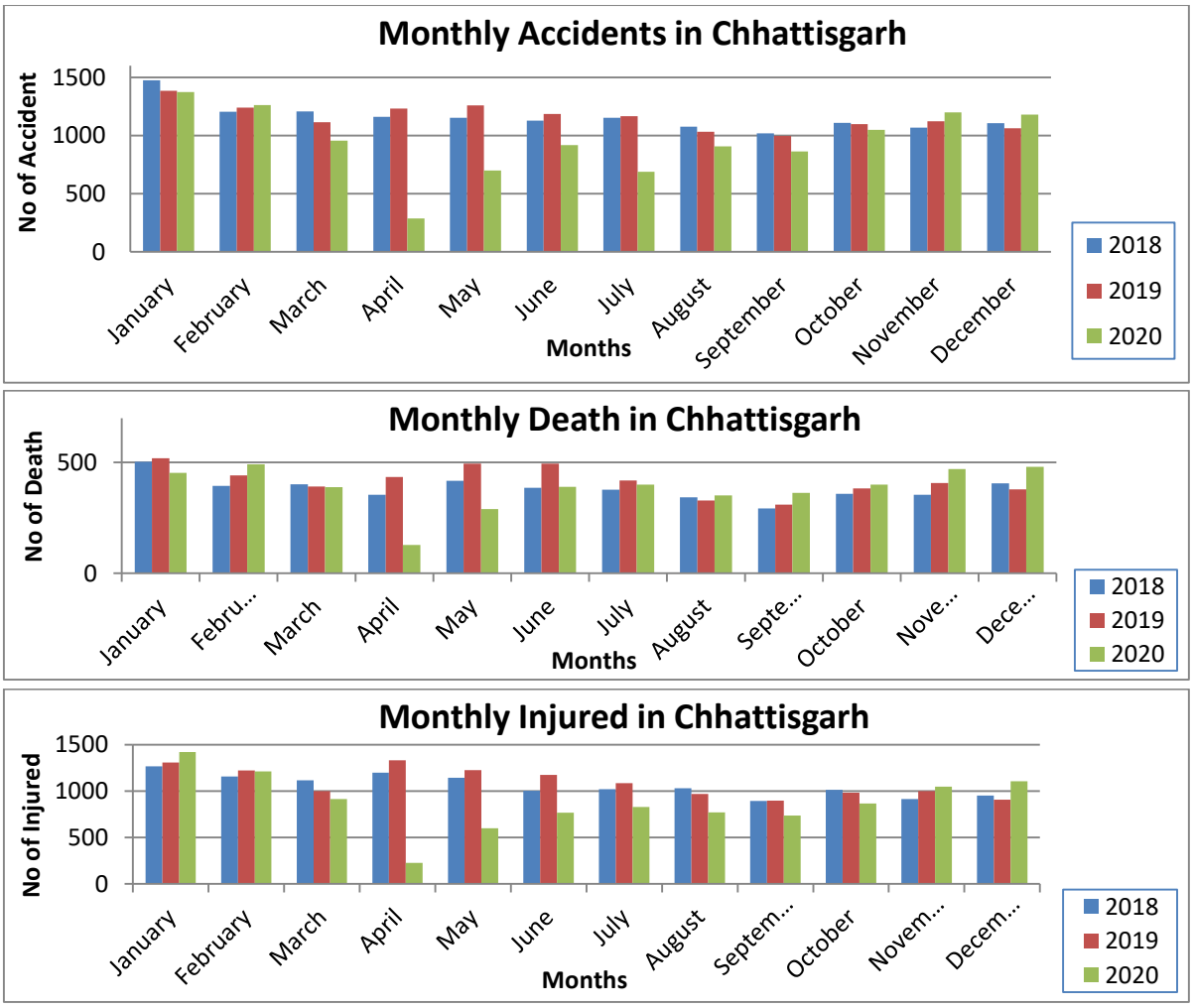

Fig No. 4. Monthly Road accident cases, deaths and injured persons in Chhattisgarh state.

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The diurnal variation of a road accident, deaths, and the injured person has been shown in Table number. 6 and fig. number 5. It is shows that the maximum number of cases in between 6-9 PM in mention three years and the minimum road accident shows in 3-6 AM, minimum in the year 2020. The minimum number of deaths registered is 12 -6 AM and the minimum number of the injured person has been shown 12-3 AM in 2019, 2020, and 3-6 AM in 2018. The maximum road accident, deaths, and an injured person show in 6-9 PM because maximum people's return their home and traffic are more congested that time. This time visibility problems and the road condition are most important basically in rural areas, state highways, and national highways.

Table no. 6. Diurnal Variation of Road Accident, Deaths and Injured

Time	Accident			Death			Injured		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
6-9 AM	1521	1426	1043	527	537	435	1384	1390	898
9 AM-12 PM	1762	2063	1691	555	644	608	1154	1984	1165
12-3 PM	2238	2238	1941	668	711	694	2091	2161	1874
3-6 PM	2788	2679	2254	956	952	959	2734	2631	2290
6-9 PM	3007	3085	2683	1077	1167	1127	2730	2964	2333
9 PM -12 AM	1437	1439	1130	455	581	476	1177	1153	874
12-3 AM	564	454	308	169	193	129	477	362	265
3-6 AM	547	515	406	185	208	178	468	434	306

Source: Police Head Quarters, Govt. of Chhattisgarh

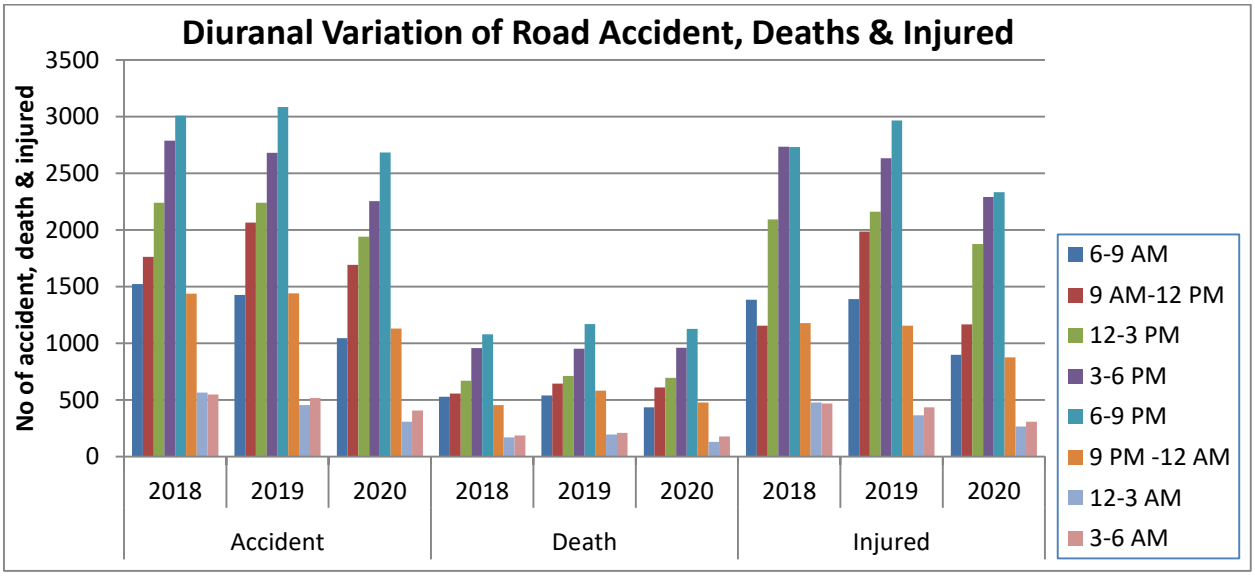

Fig No. 5. Diuranal Variation of Road Accident, Deaths & Injured

VEHICLES WISE ROAD ACCIDENT, DEATH, AND INJURED PERSON

It is believed that the growth of registered motor vehicles and the growth of population increasing rapidly than the expansion of the road network. In Chhattisgarh state, the two-wheelers registered motor vehicles more as compared to other motor vehicles. Fig. shows that maximum road accident has been found by two-wheelers, which is maximum in 2019 and minimum by E-rickshaw. In 2018, the second-highest registered accident by Cars/Light Motor Vehicles. The maximum death registered in 2019 and 2020 by 2 wheelers. The registered maximum person has been found in 2019 by two-wheelers and Car/LMV, but compared to other vehicles Truck/Lorry injured the maximum person in 2018. The accident, death, and injured person maximum affected by two-wheelers, Car/LMV and Truck/Lorry over the mention three years. The Table no. 7 and Fig No. 6 are representing the vehicles wise road accidents.

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Table no. 7. Vehicles Wise Road Accident

Type of Vehicles	Accident			Death			Injured		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
2 Wheelers	5936	6887	6425	1608	2894	2894	4842	6909	5979
Auto Rickshaw	92	392	181	51	51	41	357	471	172
Car/LMV	3290	1965	1383	1026	413	305	3440	1668	1225
Truck/Lorry	2771	1086	668	991	274	185	2037	579	465
Bus	540	260	110	187	71	23	703	477	276
E-Rickshaw	0	67	126	0	13	28	0	103	90
Others	1478	1203	839	729	536	418	1336	1439	840

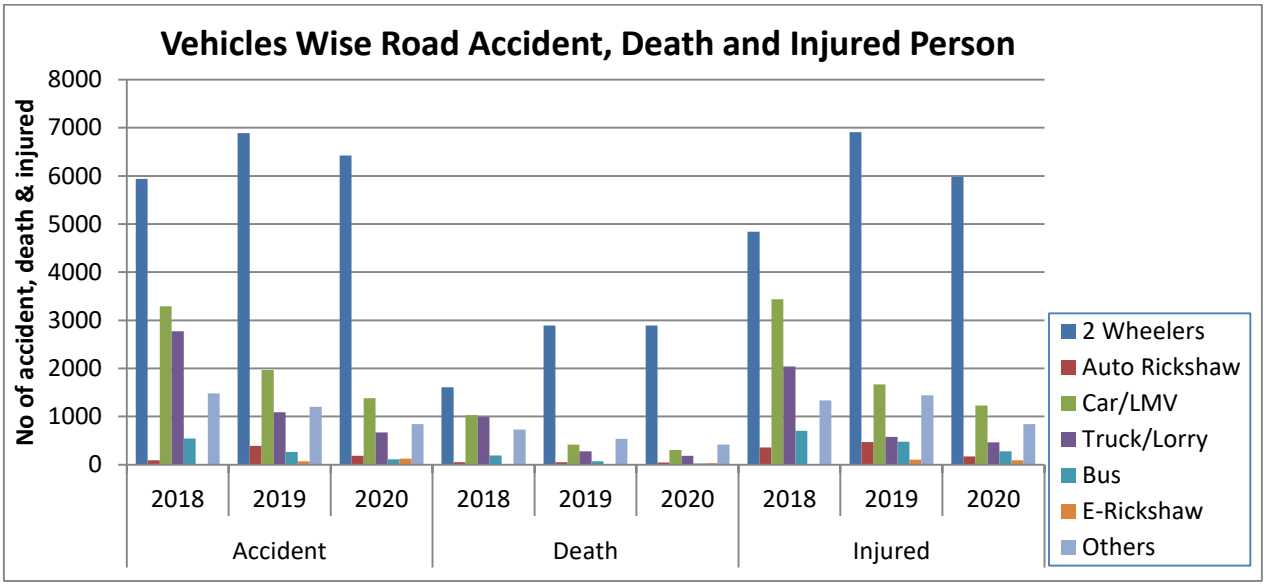

Fig No. 6. Vehicles Wise Road Accident, Death and Injured Person

ROAD AND AREA WISE ACCIDENT, DEATH AND INJURED

The table number 8 and Figure. number 7 is shows the three types of road where an accident, death, and injured person are mentioned. According to Chhattisgarh Economic Survey (2020-2021) maximum covered rural roads (13729 Km) and district roads (11501 Km) then state highways (4176 Km) and national highways (3526). The maximum road accident has been registered in Others Road, then National and State highways. Similarly death and injured persons registered maximum in Others Roads and minimum in State highways. The ratio of a total length of National, State Highways, Others road and accident, deaths, the injured maximum has been found in National Highways and minimum shows Districts and Rural Roads. Maximum accident in National and State highways due to over-speed riding, driving behavior, road conditions, extra passengers in vehicles, overloading, etc.

Table no. 8. Road Wise Accident

Type of Road	Accident			Death			Injured		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
NH	3995	3811	3463	1384	1421	1390	3592	3541	3075
SH	3136	3010	2171	1068	1166	956	2866	2906	1831
Others Road	6733	7078	6022	2140	2416	2260	6257	6643	5599

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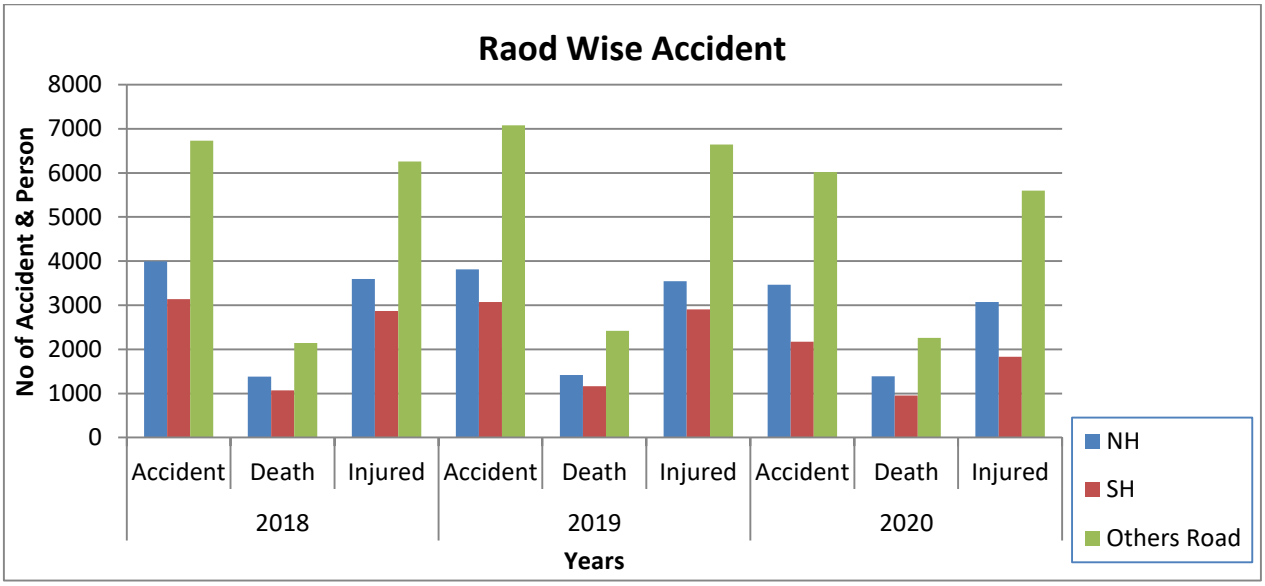

Fig No. 7. Road Wise Accident

The total population of Chhattisgarh state is 25545198 (Census of India, 2011). The maximum number of people lived in the rural area (76.76%) and the minimum lived in an urban area (23.24%). Fig. shows that accidents, death, and injured in the rural and urban areas of the state, which is maximum have been found in the rural area. But share to area wise maximum has been found in urban areas. In both rural and urban areas, maximum road accident shows in 2018 and minimum in 2020. The urban area always has been showing mixed traffic island, illegal parking, road encroachment, breaking traffic rules, etc. due to result of accident, death and injured are maximum. The table number 9 and Figure number 8 are shows the area wise accident cases.

Table no. 9. Area Wise Accident

Type of Area	Accident			Death			Injured		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Urban	4970	4792	3554	1242	1046	814	4213	4056	2920
Rural	8894	9107	8102	3350	3947	3792	8502	9023	7585

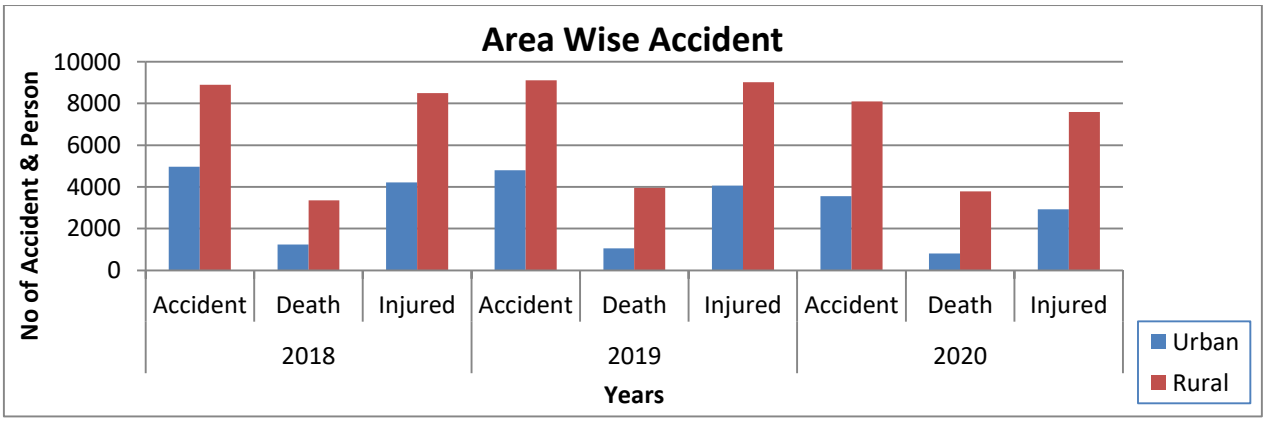

Fig No. 8. Area Wise Accident cases

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CAUSE OF ROAD ACCIDENT

The table number 10 and Figure. Numbers 8 are shows the cause-wise distribution of road accidents in 2020 in Chhattisgarh. It has been shown that two-wheelers are the single most important factor due to faulty driving behavior. The maximum registered accident (6425), death (2894), and injured (5979) by two-wheelers faulty driving. The second highest cause of road accidents is pedestrian movements on roads and then car/light motor vehicles. In urban and rural areas pedestrians are illegally moved on roads. Mainly in urban areas footpaths are encroached by illegal parking and vendors, due to this reason pedestrian movements on main roads. The traffic congestion and accident are deeply chances on roads. The minimum road accident has been found by the newly launched E-Rickshaw in the state. Fig number 10 is Showing the Relationship between Registered Vehicles and Road Accident (2001-2020)

Table no. 10. Cause of Road Accident (2020)

Cause of Accident	Accident	Death	Injured
Pedestrian	1473	575	1102
Cycle	451	137	356
2 Wheelers	6425	2894	5979
Auto Rickshaw	181	41	172
Car/LMV	1383	305	1225
Truck/Lorry	668	185	465
Bus	110	23	276
E-Rickshaw	126	28	90
Others Vehicle	839	418	840

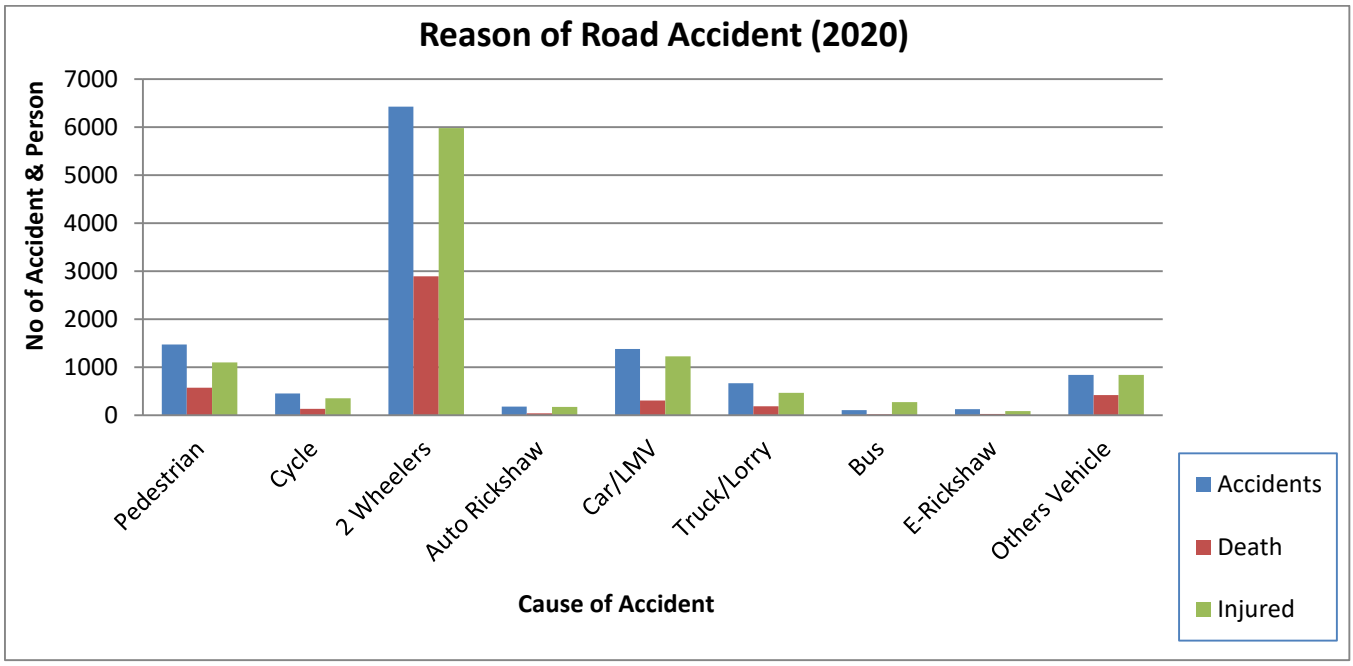

Fig No. 9. Reason of Road Accident (2020).

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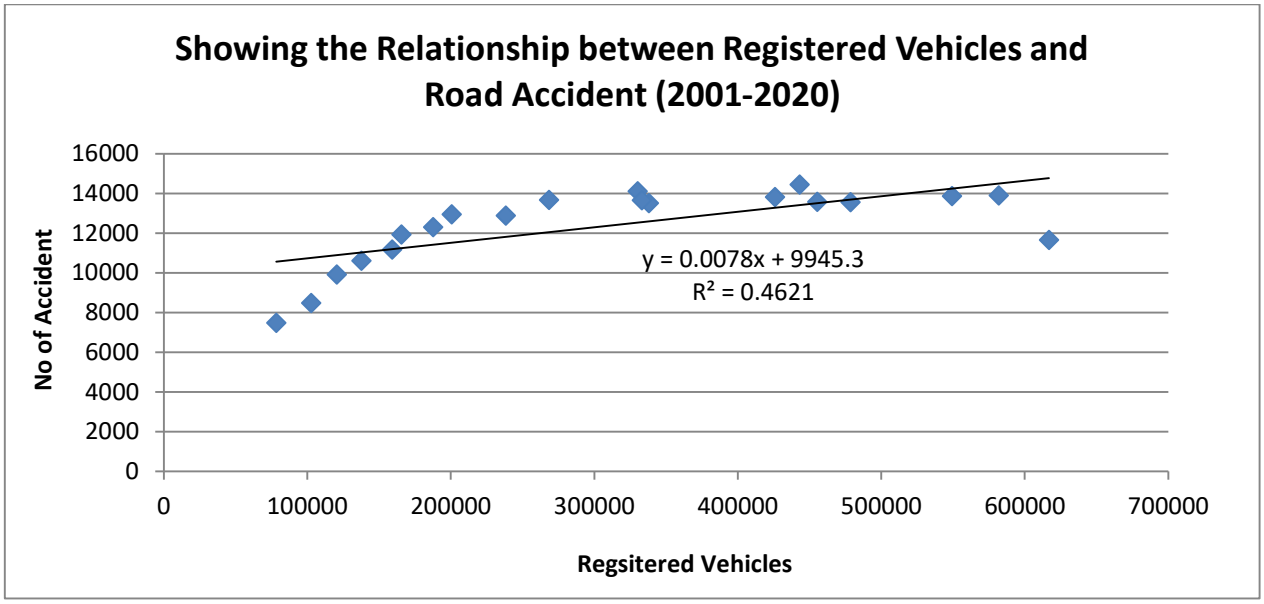

Fig No. 10. Showing the Relationship between Registered Vehicles and Road Accident (2001-2020)

The relationship between registered motor vehicles and road accidents has been shown in different years in the Chhattisgarh state. In 2001-2020, registered vehicles increased rapidly and road accidents increased alarmingly. The year-wise number of accidents and registered motor vehicles has been shown moderately correlation and the regression line indicates a positive correlation. Vehicular growth is not only the reason for increasing road accidents, death, or injured person. The others reason similarly depends on road accident like lack of proper driving skill, illegal parking on roads, street vendors, bad road condition, unconditional breaker, dumped on roar sides, breaking traffic rules, unwanted pedestrian movements on roads, overspeeding, and illegal driving licenses, etc.

CONCLUSION

The above analysis shows that road accident, deaths, and injured persons are different according to month-wise, diurnal-wise, year-wise, vehicles-wise, area, and road-wise. Moreover, day by day road accidents has been increased due to the high ratio of population and registered vehicles but proportionally road spaced and road density is not increased. The maximum road accident has been found in Raipur, Bilaspur, Durg due to maximum urbanization districts, highest registered motor vehicles, high road density, and maximum population. The minimum accident has been found in Sukma, Narayanpur, Bijapur, Dantewada due to minimum urbanization, low density of population and road network, minimum registered vehicles, maximum forest area, etc. The analyses of month-wise road accidents of, maximum are found in December and January month over the last three years. Due to low visibility and cold weather, the maximum accident has been found. The accidents are relatively high during 6-9 PM and 3-6 PM but low in the early morning (3-6 AM). The reasons for road accidents are maximum numbers by two-wheelers, pedestrian movements and according to different vehicles wise, maximum by two-wheelers, Car/Light Motor Vehicles, Truck/Lorry. The urban area indicates the minimum and the rural area indicates maximum accident because 76.76% of people lived in villages. The districts and rural roads show maximum accidents and minimum in state and national highways. In the state, the maximum road network has been covered by rural and districts roads, which are almost, cover 69.47% of all over Chhattisgarh.

The rapid increase of road accidents in the state but the central, state, or local government did not proper attention to road safety. The problem of a road accident does not belong to particular governments, either state or central or local levels. In this situation change the responsibility is confirmed and allocated to a specific agency. The central and state government take a strong step to reduce the road accident by proper traffic management, improve road design, introducing standard vehicles, wearing helmets and using a seat belt when driving, cancel illegally making driving license, speed control, aware drink, and drive, campaign again road accident, etc.

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