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Analysis of Accident Data and Identification of Blackspots in Hisar City, Haryana, India with Different Criteria

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Abstract

In India, roads are the most cost-effective mode of transportation; nevertheless, they are also the most susceptible to accidents that endanger the lives and health of drivers as well as damage cars and other property. It's critical to locate accident blackspots on various roadways and implement remedial measures there to reduce the frequency of traffic accidents. Financial limitations may sometimes make it impractical to implement countermeasures at every identified blackspot location at once. In these cases, it is crucial to rank the blackspots in order of priority and implement countermeasures in a phased manner. This paper analyzes road accident data from Hisar City in Haryana, India. The accident data are collected from the Haryana Police Website for five years (2019-2023) of Hisar City. Blackspots are analyzed using 4 different criteria that are important in the identification of blackspot locations. To determine the potential causes of accidents, the top ten identified blackspot locations have undergone extensive investigation and analysis. Based on the study's findings, countermeasures targeted at reducing traffic accidents in these locations have been proposed.

1. INTRODUCTION

Road traffic accidents (RTAs) are a growing concern worldwide, leading to numerous injuries, fatalities, and economic losses. In India, the increasing population and vehicle ownership have exacerbated the situation, making road safety a pressing issue. Hisar, a rapidly developing urban area in Haryana, has experienced a rise in traffic-related incidents, highlighting the urgent need for thorough accident analysis and the identification of critical risk areas to improve safety on its roads.

Accident blackspots are specific locations where accidents tend to cluster, indicating the need for targeted safety measures. These black spots are identified based on several criteria, such as accident frequency, severity, and traffic volume. The process of determining these hazardous locations is vital for developing strategies to reduce accidents and enhance traffic safety. Using a multi-criteria approach allows for a more comprehensive assessment of accident-prone areas, providing valuable insights into the underlying causes.

Hisar serves as an important transport hub in the region, with its road infrastructure seeing increased pressure due to urbanization and economic growth. This has led to congestion and higher accident risks, particularly in certain areas that demand focused attention. Despite the growing concern, there has been limited research on identifying specific accident blackspots in the city. A systematic study is therefore needed to analyze accident data and

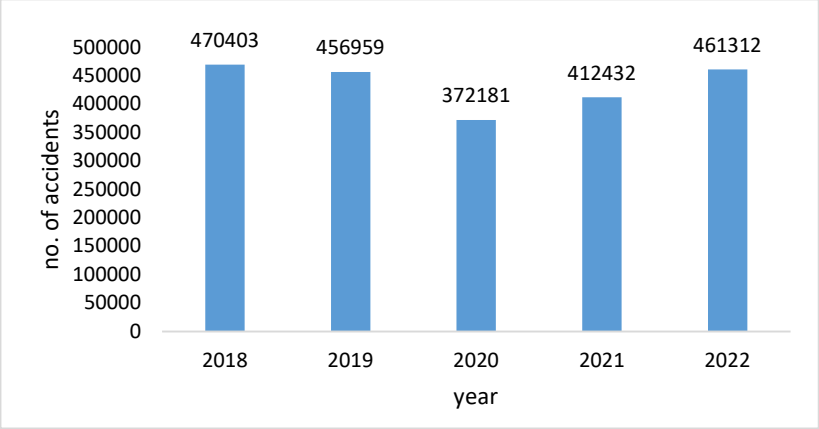
recognize the most dangerous locations.

In this paper, we will outline the methodology used to identify blackspots, present the results of our accident data analysis, and discuss their implications for road safety improvements in Hisar and similar urban areas across India.

1.1 Road Accidents Overview in India

For the calendar year 2022, States and Union Territories (UTs) have recorded a total of 4,61,312 road accidents, resulting in 1,68,491 fatalities and 4,43,366 injuries. Compared to the previous year 2021, there were 11.9 percent more traffic accidents in 2022. Comparably, there was an increase of 9.4% and 15.3%, respectively, in the number of fatalities and injuries caused by traffic accidents (Chart 1). These numbers equate to 1,264 crashes and 462 lives every day on average, or 53 crashes and 19 lives per hour throughout the nation. [1]

Chart-1. Accident data of (2018-2022) India

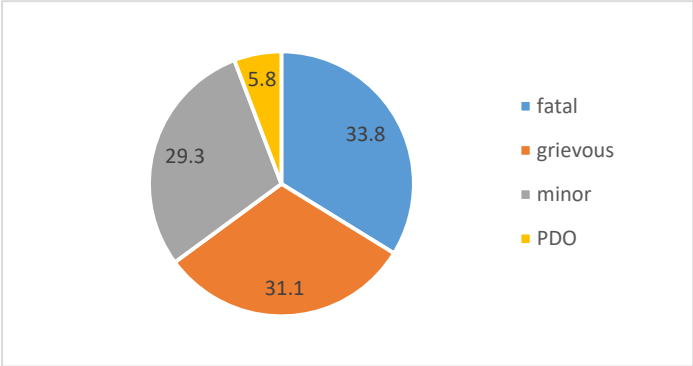


During 2020 a large decrease in accidents can be seen in the data, it is due to covid-19 pandemic. It is approx. two-year lockdown sudden decrease in road crashes over all India.

One of the primary causes of death worldwide is traffic accidents, which primarily affect people between the ages of 15 and 49. [2]

Types of accidents- In India, traffic accidents resulted in around 4.4 lakh injuries and 1.68 lakh fatalities in the calendar year 2022. A total of 4,61,312 incidents were reported in 2022; of these, 1,55,781 (33.8 percent) resulted in fatalities, while 2,78,734 (60.4 percent) caused injuries (minor and severe). Of the injuries resulting in accidents, 1,43,374 (31 percent), were severe, and 1,35,360 (29.3 percent) were minor (Chart 2). The overall number of fatal crashes, minor crashes, and non-injury crashes in 2022 is higher than it was the year before. [3]

Chart-2. Types of Road Accidents in 2022.



Category of Roads- Here we discuss what is the effect of types of roads on the accident data.

Table 1. Road category-wise data of India 2022

Category of road	Accidents	Killed	Injured
national highway	32.9	36.2	32.6
state highway	23.1	24.3	24
other roads	43.9	39.4	43.4
All Roads	100	100	100

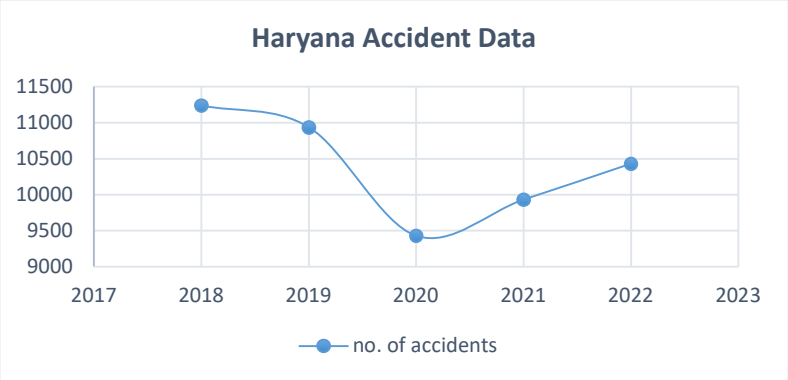
***Note**: All data are in percentages in Table 1.*

The country's highways, which make up around 5% of the country's overall road network, account for more than 55% of all accidents and greater than 60% of fatalities. This indicates that the highway system needs improvement. The breakdown of accidents and fatalities by category is shown in Table 1. Table 1. shows that 32.9% of all accidents and 36.2% of all fatalities on national highways occurred in 2022.

1.2 Road Accident Overview in Haryana

Haryana is an agricultural state that makes a large contribution to the Indian economy. Also, Haryana plays an important role in road accidents percentage. Haryana is at 14th rank in road accidents in India but last year it came at 13th rank in 2022 with an increasing 4.4 percent fatalities rate from last year's data 2021.

Chart-3. Accident data of Haryana (2018-2022)



In terms of deaths, 5,118 occurred in Haryana in 2018, 5,057 in 2019, 4,507 in the year 2020, 4,706 in 2021, and 4,915 in 2020. The founder president of TRAX, an organization dedicated to road safety, Anurag Kulshreshtha, stated that the reason for the increase in crashes in Haryana is the fast development of motorways and highways, which see high-speed traffic movement that causes accidents.

2. LITERATURE REVIEW

Kashid et al. (2008) [4] introduce the concept of identification of blackspots with three methods in this research paper. These methods are (i) method of ranking and severity index (ii) accident density method and (iii) weighted severity method. This research on National Highway 48 passes through Pune a 12 km stretch between Bhujbal Chowk to Chandni Chowk.

Bhover et al. (2019) [5] introduce the simple method of identification of black spots. The stretch is taken of Belagavi city an educational centre of Karnataka. A stretch of 11km is studied. The data contain three-year (2015-2017) accident reports of this stretch no. of accidents per year, type of vehicle involved, age group of victims, PCU, and road geometry of 6 accident blackspots at this stretch.

Achan (2015) [6] identifies various road-related factors and traffic parameters and possible suggestions for improvement. The stretch is located in Dakshina Kannada district of Karnataka in Puttur Taluk (NH-75) and is 58 KM from Nelyadi to Sakaleshpura. Its data contain the last 4 years' accident details, traffic volume survey, socio-economic parameters, and geometrical details about separate junctions and locations. GIS is used to analyze blackspot locations by visual and topographical study of maps of that area. The buffer zones are created according to the accidental data in GIS.

H. A. S. Sandhu (2016) [7] worked on identifying black spots on a select stretch with the kernel density estimation method. The case study is done on the national highway of Gurgaon and Jaipur (NH-8). Data is collected from 2010-2012 from NHAI. In this research GIS software is used for blackspot visualization and analysis then the kernel density method is used and two other methods are also used.

Varun Kumar and Rahul Bansel (2016) [8] Identified the 3 black spot locations (i) NH-19 and 65, near BSF Camp (ii) near Hindustan Petroleum Hisar Balsamand road, and (iii) near GJU bypass road of Dehli near Cantt

road. The method uses regression analysis where a relation is built up of different independent variables, and a linear relationship occurs between dependent and independent variables.

Sunny Tanwar and Sachin Dass (2017) [9] used a simple analysis method for the identification of blackspots on NH-65, Hisar City to Behbalpur village in Hisar District Haryana, India. A stretch of 17.4km is studied. The data contain FIVE-year (2011-2015) accident reports of this stretch no. of accidents per year, type of vehicle involved, age group of victims, Timing groups, hourly, yearly, seasonally, and type of collision of 6 accident blackspots at this stretch.

Sanjay Kumar Singh (2017) [10] describes the road accident issues and challenges in India. Analyses the road accident scenario at the national level like road accident death and injuries in India, age and sex-wise distribution, month and time-wise distribution, cause of accidents, and analysis at the state level and city level also.

Esmaiel Karimi Maskooni (2018) [11] , **Maen Ghadi (2019)** [12] and **Kirat Kaur (2017)** [13] studied the different methods of identification of blackspots and evaluated the best method. He studied the accident frequency (AF), equivalent property damage only (EPDO), p-value, combined criteria, empirical Bayes (EB), and accident rate (AR) 6 different methods that found the empirical bays method is the best method of the exact location of accident blackspots.

Brhane Gebretensay et al. (2018) [14] A simple analysis method was used to identify blackspots in Vadodara City, Gujarat, India. The data contain seven-year (2010-2016) accident reports of this stretch no. of accidents per year, type of vehicle involved, age group of victims, Timing groups, hourly, yearly, seasonally, and type of collision of 8 accident blackspots at this stretch.

Wanit Treeranurat (2021) [15] studied the determination of blackspots on rural roads in Thailand by using accident equivalent no. and upper control limit. He studies the different criteria used in different countries like no. of accidents, and no. of fatalities required for proof of an accident blackspot, and **Keymanesh (2017)** [16] studied on prioritization of blackspots after analyzing different goals.

Keshav Bammel and Sachin Dass (2021) [17] discuss the accident prediction model of Hisar City of road safety conditions and statical analysis also. This paper analyses of accident severity index (ASI) of different cities of Haryana and then compares Hisar and Haryana fatality rates, accident rates, and severity rates. **Damgir (2022) [18]** states the identification of blackspots at NH-52(NH211) from Beed bypass road to Maha Anubhav Ashram t- point a 13.15 km stretch are studied.in this author makes the high severity timing graph and type of vehicle involved at this time.

Prayag and Gyanendra (2022) [19] analyzed the accident blackspots with different four criteria. The author studied the National Highway 44 from Kundali to Panipat and found the top 10 blackspot locations at this stretch after comparing the ranking of four criteria.

Athhiappan (2022) [20] analyzed the emerging blackspot locations with geospatial factors, ranking with road geometry criteria, and Wan Yan (2021) [21] and **Victoria Gitelman (2016)** [22] studied the empirical bays method deeply in their work after the identification of black spot location.

Cheng Zhang (2016) [23] studied the k-means, bayesian method, and algorithms classification of blackspot locations in his research work, and **Jensy Maria and Vishnu (2018)** [24] identified the blackspot based on WSI and analyzed the blackspot location after prioritization based on road geometry ranking.

3. METHODOLOGY

In the present study, an accident blackspot in a Hisar city has been identified according to MORTH definition that the Blackspot sites are those places or road segments of roughly 500 meters that have five or more accidents or ten or more fatalities in the three years between 2021 and 2023. The Haryana Police website provided historical accident data, which was then analyzed concerning the date, time, and month of the incidents, the location of the incidents, the number of fatalities, the number of injured and dead (both serious and minor), the vehicles and other road users involved, and the nature of the collisions. Google Maps has been used to identify the sites of the crashes and estimate the distances between various locations.

In Hisar City, we studied the five police station accident data, including the city area, and analyzed the last five years' data (2019-2023).

The step-wise flow chart of the methodology of this study is shown in below Chart 4.

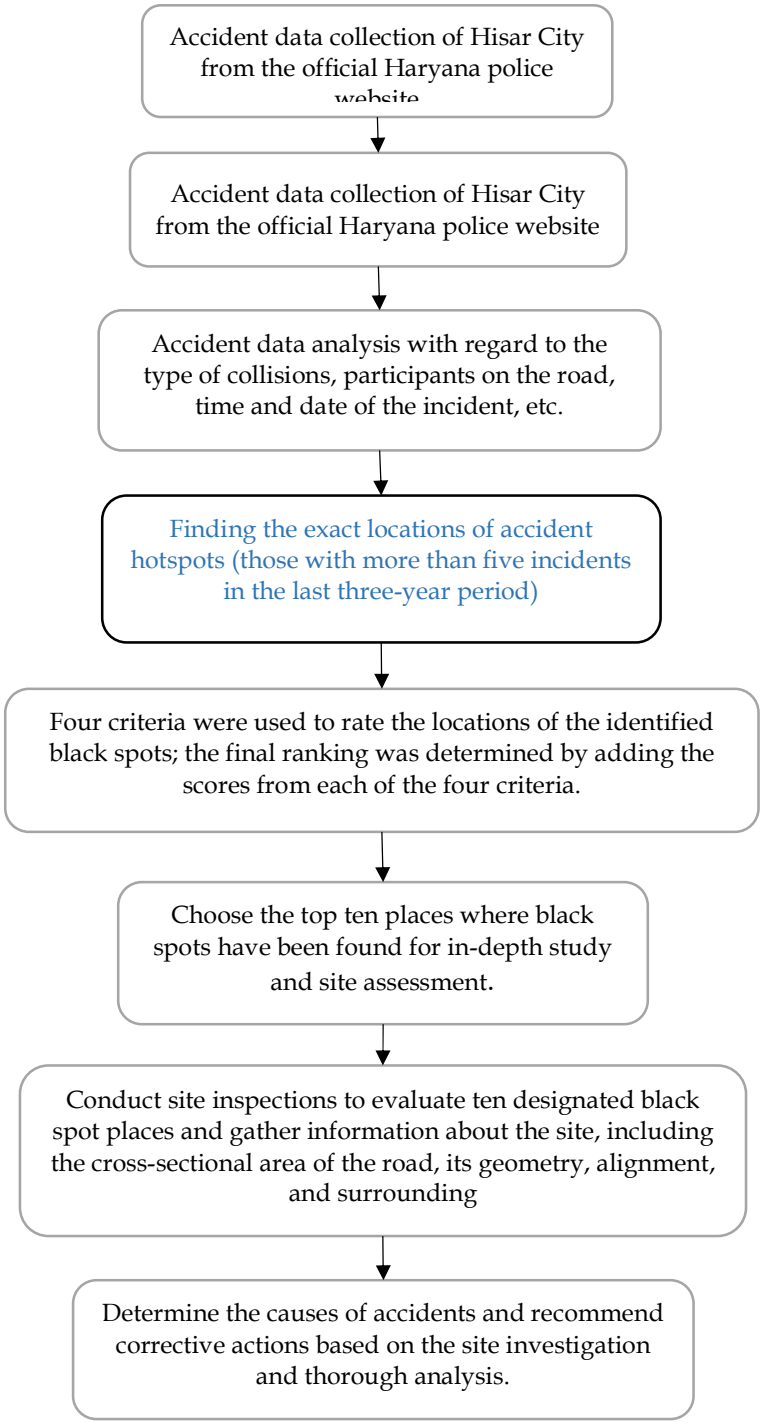


Chart-4. The step-wise flow chart of the methodology of this study

4. THE STUDY AREA

The study area is Hisar City situated in Haryana, India. Five police stations (Azad Nagar, Hisar City, Hisar civil lines, HTM Hisar, and urban estate Hisar) accident data situated in the Hisar city boundary is collected and analyzed.

Hisar is an educational center of Haryana that has 5 universities (Haryana Agriculture University is the largest university in Asia) and 31 colleges (10 government and 21 private). Construction of Hisar airport is in progress. Hisar is connected with NH-10, NH-65, NH-9, NH-52, NH-709A, NH-17 and NH-12.

Hisar is one of Haryana's rapidly expanding cities. The administrative center of the Hisar district is located in this city, which is well-known for its planned neighborhoods. It serves as the National Capital Region's counter-magnet city and is only 164 kilometers from New Delhi. This city is already beginning to develop as a different growth hub close to Delhi, which is why tourists continue to flock here to discover. Recently, Hisar has been recognized as the greatest city in India for manufacturing galvanized iron. Because of the large number of steel industrial facilities in the area, it is also known as "the City of Steel."

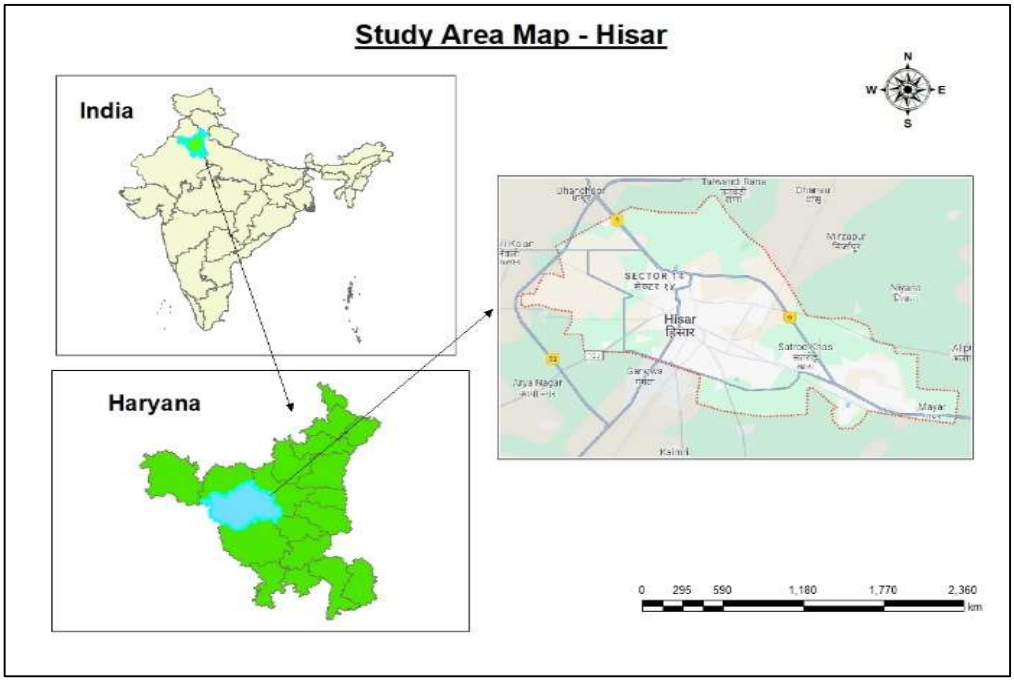


Fig.- 1 Study Area of Hisar City

5. ACCIDENT DATA ANALYSIS

According to accident data gathered from the Haryana Police website, there were 459 accidents in Hisar City throughout the five years between 2019 and 2023: 118 in 2019, 83 in 2020, 101 in 2021, 76 in 2022, and 81 in 2023. Below is a breakdown of these 459 collisions in terms of the number of people killed and injured, the type of collisions, the time and months they occurred, and the road users involved.

5.1 Variation of Accidents (Yearly)

In 2019,2020,2021 more than 50% of injuries were grievous, but in 2022,2023 more than 40% of injuries were minor, which means safety is increasing day by day in Hisar City. The maximum fatality rate is 24% in 2022 and the maximum property damage accidents (34%) occur in 2023.

Chart 5: Yearly variation of Accidents data of Hisar City from 2019-2021

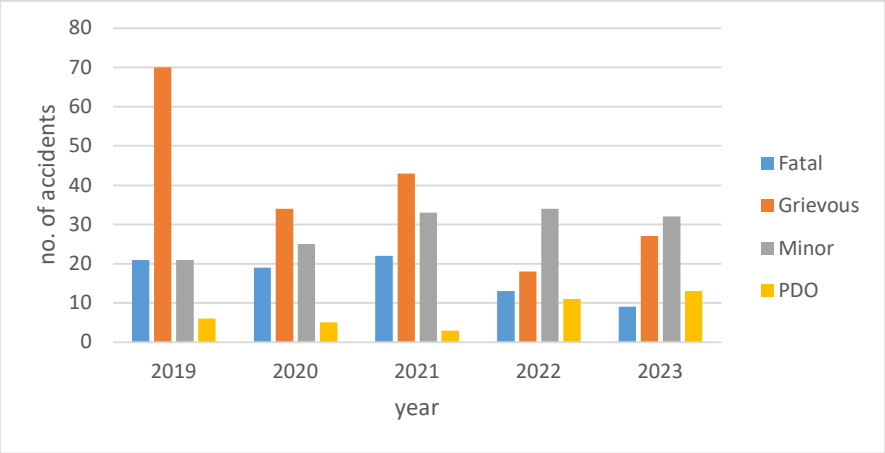


Chart 5**,** Represents the 459 numbers of accidents that took place from the year 2019-2023.

5.2 Fatalities and Injuries Due to Road Accidents

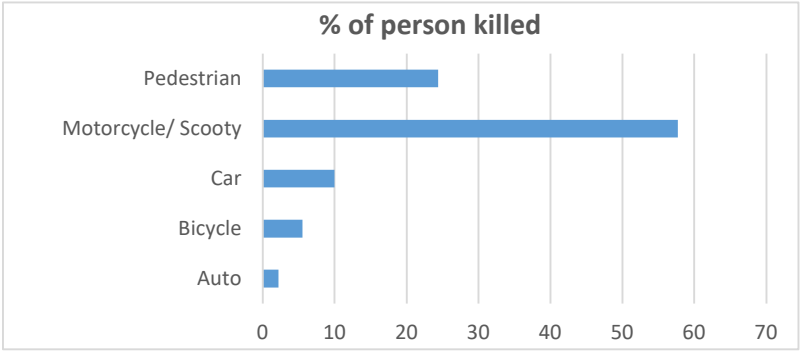
Table 2 shows the number of people killed and injured in traffic accidents in Hisar City between 2019 and 2023. Out of the 459 accidents that happened in Hisar City throughout the period, more than 18.3% resulted in fatalities, killing 90 people, and almost 73.4% caused injuries, injuring 240 people with light injuries and 246 people with severe injuries. The remaining 8.2% of accidents simply resulted in property damage.

Table 2: It shows the injuries and fatalities caused in Hisar City during 2019-2023

Type of fatalities and injury	number
Number of road accidents	459
Number of fatal accidents	84
Number of persons killed	90
Number of injury accidents	337
Number of persons injured	486
(a) Grievous injuries	246
(b) Minor injuries	240
Number of Property Damage Only accidents	38

Chart 6: Categorises the fatalities from accidents in Hisar City over the research period based on the victim road user group. According to the data, Motorcycle/ Scooty made up the largest percentage of accident fatalities (57.7%) and were followed in mortality rate by pedestrians (24.4%).

Chart 6: Road user category-specific classification of accident deaths in Hisar City



5.2 Road User Types Linked to the Incidents

Table 3 presents an analysis of the road user types engaged in the accidents in Hisar City under consideration, based on the data collected from 2019 to 2023. A road collision often involves two drivers, however, occasionally there may be simply one or more drivers involved. Road users were divided into nine categories for this study: Truck/tanker/dumper, buses, tractors, Car/van /ambulance, Canter/pickup, Auto/E-rikshaw, two-wheelers (bikes/scooters), bicycles, and pedestrians/handcart. Furthermore, the driver who has been the subject of a formal complaint is regarded as the at-fault driver, while the victim driver is the one who has incurred harm as a result of the collision.

Table 3: Road user types involved in incidents that happened in the research region between 2019 and 2023.

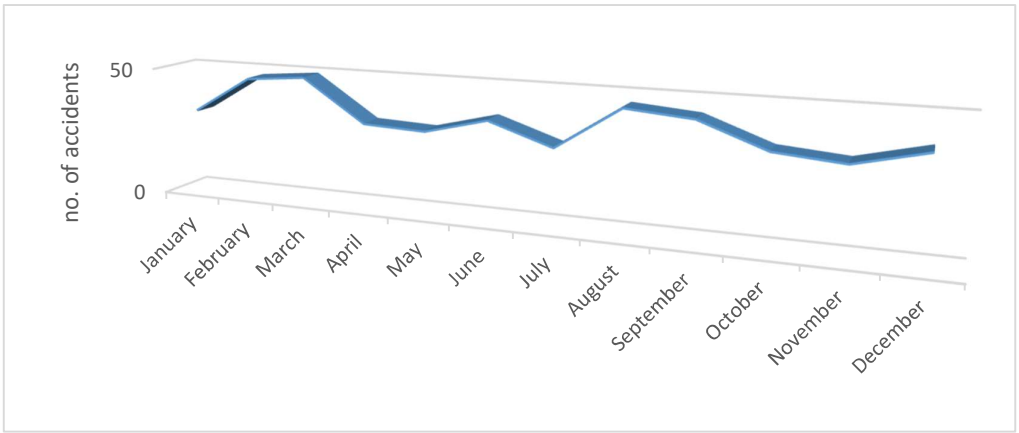
Road User	no. of accidents where the road user is the culprit	no. of accidents where road users are victims
Auto/E-rikshaw	15	16
Bus	27	-
Canter/pickup	21	-
Car/van /ambulance	250	56
Bicycle	1	16
Motorcycle/ scooters	73	259
Tractor	10	3
Truck/tanker/dumper	43	-
Unknown	19	-
Pedestrians/handcart	-	109
Total	**459**	**459**

Table 3 demonstrates that the road user's Car/van /ambulance was the most common. They caused more than 54.4% of all road accidents (250 from 459), with Motorcycle/ scooties coming in second with 15.9% of all incidents. The majority of victims on the road were Motorcycle/ scooties (259 out of 459, or around 56.4% of all accidents). Pedestrians/handcarts came in second with 109 victims, or almost 23.7% of all accidents.

5.3 Month-wise accident data distribution

The monthly total of traffic accidents in Hisar City from 2019 to 2023 is shown in Chart 7. It can be observed that May, July, and April had the fewest incidents, while March, February, and August recorded the most accidents—49, 47, and 46, respectively. The rainy season from June to September and the Holi celebration season in February and March can be blamed for the increased number of accidents in Hisar City during those three months.

Chart-7: Represent the monthly data distribution



5.4 Weekday-wise distribution of accidents

Table 4 shows the weekday data in Hisar City from 2019 to 2023. The table shows that the maximum number of accidents occurring on Wednesday is 17% and the minimum on Sunday is 2.6% due to holidays of colleges and departments.

Table 4: Weekday-wise distribution of accidents

weekday	no. of accidents	weekday	no. of accidents
Monday	73	Friday	56
Tuesday	45	Saturday	58
Wednesday	78	Sunday	64
Thursday	72	intervening day	13

5.5 Accidents categorized according to the kind of collisions

The sort of collisions that account for the most accidents (30%) is head-end collisions, followed by rear-end collision which accounts for more than 27% of accidents, followed by pedestrian hitting more than 20% of accidents, according to the study of accident data (Table 5). The only explanation for the increased frequency of head-on incidents is irresponsible driving on the part of the wrong side, crossing the restricted yellow line, overtaking the front vehicle carelessly, and most importantly overspeed which is not applicable brake. Additionally, pedestrians' crossing of the road is a significant component in the high number of traffic accidents and fatalities in Hisar City. As such, this issue must be taken into account while implementing preventative measures to reduce the number of accidents along this stretch of road.

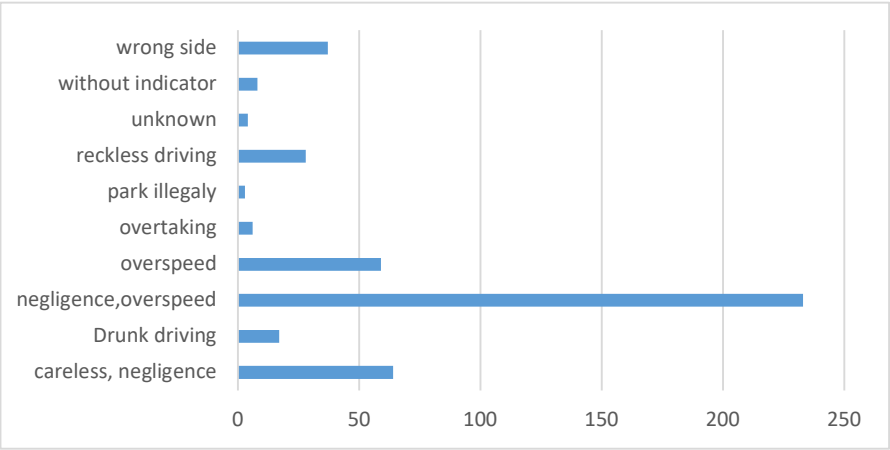
Table 5: Accidents categorized according to the type of collision

Type of collision	numbers of accident	Type of collision	numbers of accident
Head on collision	138	standing vehicle	1
overturning	1	T-Bone collision	37
pedestrian hitting	96	unknown	14
Rear end collision	126	vehicle slip	1
Sideswipe	44	without indicator	1

5.6 Break down of data according to the cause of accidents

Chart 8 shows the data of accidents caused in Hisar city from 2019-3023. Here the maximum number of accidents that occur due to negligence, and overspeed is more than 50% and followed by careless, negligence is more than 13% of total accident data. Overspeed plays an important role in more than 60% of accidents due to this.

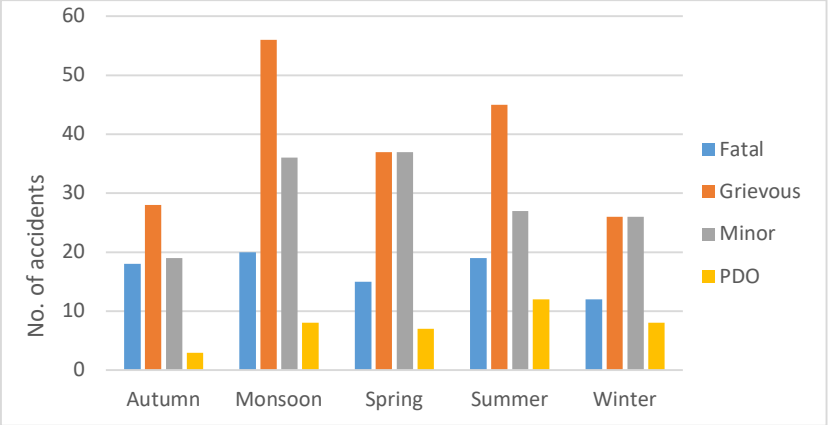
Chart 8: Analysis according to causes of accidents



5.7 Based on Seasons

Figure 9 shows the accident severity in every 5 seasons. Monsoon season saw the highest number of accidents (40%) due to heavy rain and slippery road conditions. Autumn has beautiful weather and a clear view, so fewer accidents occur in the Autumn season.

Chart 9: Accident Severity with Season



6. IDENTIFICATION OF ACCIDENT BLACKSPOTS

High-risk road sections that have seen an abnormally high number of accidents relative to other areas within a given time frame are known as accident blackspots. Locations with five or more accidents throughout the last three-year study period or 2019–2023, have been designated as accident blackspots. Consequently, Hisar City, Haryana, India has been found to have 18 blackspots; 4 of these are on Rajgarh Road, 4 are on Sirsa Road, and 2, 2, 2, are on Hisar-Delhi Bypass, Hisar Ghursal Road, Mall Road, and other roads are defined below with black spot locations. Table 6 provides the accident statistics for these 18 locations.

Table 6: Details of accidents of 18 blackspot locations for 2019-2023

Black spot location (1)	no. of total accidents (2)	no. of fatal accidents (3)	no. of grievous accidents (4)	no. of minor accidents (5)	no. of PDO accidents (6)
1	18	6 [3]	5 [8]	4 [6]	3
2	17	3 [3]	8 [8]	6 [6]	0
3	12	3 [3]	5 [9]	3 [7]	1
4	15	1 [1]	6 [6]	6 [7]	2
5	11	2 [2]	3 [4]	4 [7]	2
6	10	2 [2]	4 [6]	3 [5]	2
7	8	0 [0]	2 [2]	3 [3]	3
8	11	0 [0]	3 [3]	6 [11]	2
9	10	0 [0]	3 [3]	5 [6]	2
10	9	0 [0]	2 [2]	6 [6]	1
11	15	1 [2]	11 [16]	3 [9]	0
12	13	4 [4]	3 [6]	6 [9]	0
13	8	3 [3]	2 [2]	3 [4]	0
14	11	1 [1]	6 [9]	4 [4]	0
15	18	1 [1]	6 [9]	9 [11]	2
16	9	3 [3]	4 [4]	2 [2]	0
17	9	1 [1]	4 [4]	3 [4]	1
18	9	4 [5]	1 [2]	3 [6]	1

1. Gangwa (Hisar Rajgarh Road), 2. Bus Stand (Sirsa Road), 3. Dabra Chowk (Mall Road), 4. Azad Nagar (Hisar Rajgarh Road), 5. Near Aadhar Hospital (Dabra Chowk Road), 6. Rajgarh Road Naka (Hisar Rajgarh Road), 7.

Fawara Chowk (Hisar Ghursal Road), 8. Old Sabzi Mandi (Jat Dharamshala Road), 9. Parijat Chowk (Hisar Ghursal Road), 10. Near Court Hisar (Hisar Rajgarh Road), 11. Sector 14 (Sirsa Road), 12. South Bypass Sector 16/17 (Hisar Southern Bypass), 13. In Front Of GJU (Ambala Hisar Road), 14. Jindal Pul (Sirsa Road), 15. Near MG Club (Hisar Dehli Bypass), 16. New Sabzi Mandi (Raipur Road), 17. PLA Market (Mall Road), 18. Sirsa Chungi (Hisar Delhi Bypass)

Note: *Numbers in round brackets show the number of persons killed, number of persons grievously injured, and number of persons minorly injured in the accident of blackspot location shown in columns number 3, 4, and 5.*

PDO: *property damage only*

6.1 Blackspot Location Ranking

Corrective action is necessary in accident blackspot areas to reduce the incidence of traffic accidents and protect other road users. However, corrective action cannot always be implemented at every site simultaneously due to resource constraints. Making a priority list of the blackspot sites is therefore crucial, with the most dangerous area receiving the highest rating and the least dangerous location receiving the lowest rank. The final rankings have been provided based on the rankings from the four criteria that have been used to rate the discovered blackspot locations in this study. These criteria are the most often utilized in India and other nations.

- **CRITERIA 1:** (ASI) relative accident severity criteria proposed by NHAI

  ASI = WSI/A_N, where WSI is the weighted severity index, and A_N is the total no. of accidents at this blackspot location.
  In this method, for each blackspot location, ASI is calculated, and with a higher ASI that location is ranked higher.

  WSI = 7 × number of fatal accidents + 3 × number of grievous injury accidents + number of minor injury accidents.

  The blackspot locations in the current study, however, have been ranked using the WSI rather than the previously mentioned ASI. This is because when ranking is done using ASI, locations with a higher accident rate but the same WSI value typically return lower ranks, which appears to be acceptable.

- **CRITERIA 2**: (APW) accident point weightage criteria

  Accident point weightage = 6*a + 3*b + 0.8*c + 0.2*d
  (* symbol for multiply)

  Where, a = no. of fatal accidents, b = no. of grievous injury accidents, c = no. of minor injury accidents, d = no. of property damage only accidents.

- **CRITERIA 3:** (EPDO) equivalent property damage criteria

  EPDO = 9.5*number of fatal and severe injury accidents + 3.5*number of minor injury accidents + 1*number of property damage only accidents.
  (* symbol for multiply)

- **CRITERIA 4:** (WSI) weighted severity index criteria

  This criterion is based on the number of killed persons and persons injured in road crashes.

  WSI = 41*K + 4*GI + 1*MI
  (* symbol for multiply)
  Where K = no. of persons killed, GI = no. of persons grievously injured, and MI =no. of persons minorly injured.

  To arrive at the final rankings of the blackspot locations that have been identified, each location is first ranked using one of four criteria. The locations are then totaled, and the location with the lowest total rank is given the highest rank (1). As a result, the final rankings for various areas are determined.

Table 8 displays the final rankings as well as the individual rankings of the 18 blackspot locations that were found based on criteria 1 through 4. The 10 most popular blackspot locations are shown in table-9 below with ranks one to ten.

Table 8: The locations of the identified blackspots ranked according to Criteria 1 through 4

Black spot location	WSI score & rank as criteria 1	APW score & rank as criteria 2	EPDO score & rank as criteria 3	WSI score & rank as criteria 4	sum of all four ranks and the final rank
1	61 [1]	54.8 [1]	121.5 [3]	284 [1]	6 [1]
2	51 [2]	46.8 [2]	125.5 [1]	161 [5]	10 [2]
3	39 [5]	35.6 [5]	87.5 [6]	166 [4]	20 [5]
4	31 [9]	29.2 [9]	89.5 [5]	72 [13]	36 [9]
5	27 [13]	24.6 [13]	63.5 [11]	105 [10]	47 [13]
6	29 [11]	26.8 [11]	69.5 [10]	111 [9]	41 [10]
7	9 [18]	9 [18]	32.5 [18]	11 [18]	72 [18]
8	15 [15]	14.2 [15]	51.5 [15]	23 [15]	60 [15]
9	14 [16]	13.4 [16]	48 [16]	18 [16]	64 [16]
10	12 [17]	11 [17]	41 [17]	14 [17]	68 [17]
11	43 [3]	41.4 [3]	124.5 [2]	155 [6]	14 [3]
12	43 [4]	37.8 [4]	87.5 [7]	197 [3]	18 [4]
13	30 [10]	26.4 [12]	58 [14]	135 [8]	44 [12]
14	29 [12]	27.2 [10]	80.5 [8]	81 [12]	42 [11]
15	34 [7]	31.6 [6]	100 [4]	88 [11]	28 [6]
16	35 [6]	31.6 [7]	73.5 [9]	141 [7]	29 [7]
17	22 [14]	20.6 [14]	59 [12]	61 [14]	54 [14]
18	34 [8]	29.6 [8]	59 [13]	219 [2]	31 [8]

Note: *Using various criteria, the numbers in brackets represent rankings.*

The Gangwa main road has the 1st ranking in blackspots, followed by the Hisar bus stand main road at 2nd ranking. The main blackspot locations are along the Hisar-Rajgarh road stretch. The APW method (criteria no. 2) provides the maximum accuracy for identifying blackspot locations, while the EPDO method (criteria no. 3) provides the minimum accuracy.

Table 9: Blackspot ranking of Top Ten locations

Sr. no.	Black spot location	Rank
1	*Gangwa (Hisar Rajgarh Road)*	1
2	*Bus Stand (Sirsa Road)*	2
3	*Sector 14 (Sirsa Road)*	3
4	*South Bypass Sector 16/17 (Hisar Southern Bypass)*	4
5	*Dabra Chowk (Mall Road)*	5
6	*Near MG Club (Hisar Dehli Bypass)*	6
7	*New Sabzi Mandi (Raipur Road)*	7
8	*Sirsa Chungi (Hisar Delhi Bypass)*	8
9	*Azad Nagar (Hisar Rajgarh Road)*	9
10	*Rajgarh Road Naka (Hisar Rajgarh Road)*	10

6.2 Investigation of blackspots

The top 10 blackspots were thoroughly examined and evaluated to identify the most likely reasons for mishaps and, consequently, recommend preventative measures at each location. To find out if accidents at a blackspot happened at a specific time or in a specific way, the accident details of each blackspot, including the date and time of occurrence, location, number of people killed and injured, vehicles involved, and description of accident/collision, were first carefully studied and analyzed. The locations of the identified blackspots were visited for site inspection once this thorough information was obtained, and the following data/information was gathered

for each location.

(i) Road condition of blackspot location
Here we collect the traffic volume, road geometry, no. of lanes, lane width, surface condition, facilities of drainage, surface errors, median facility, and pavement type.

(ii) Image capturing
Collecting all blackspot site photos after observing the reason for the accident at that place, taking the the photo of things that have to be corrected at that place like signal lighting, crossing, breakers, etc.

(iii) Survey through checklist
At the Blackspot location, we perform a survey of persons who live near that location or use that location daily. Collect the information on how we can improve the place for the safety of people.

Fig. 2 shows the blackspot location of Dabra Chowk which shows that signal lighting not working, no crossing available, no traffic police for manual guiding, and the brigades are not properly used.

Fig. 3 shows the blackspot location, Azad Nagar which shows that signal lighting is not working in Azad Nagar, there is no pedestrian crossing, no road marking, and improper roadside parking.

Fig. 4 Shows the Blackspot Location South Bypass Sector 16/17 which shows that there is no median between two lanes of road, vehicles are overtaking in opposite lanes, restricted overtaking zones are not available, and reflecting lights or paint on side brigades are not available.

Fig. 5 Shows the Blackspot Location Rajgarh Road Naka which shows that there is no pedestrian crossing marking and no signal light for this T-junction. There is no Give Way sign board and no junction marking. The sight distance is not clear at the corner of the conflict point.

7. RESULTS AND OUTCOMES

This study identified 18 blackspot locations based on a thorough review of the 5-year accident data of five police stations (Azad Nagar, Hisar City, Hisar civil lines, HTM Hisar, and urban estate Hisar) of Hisar City situated in Haryana, India was conducted between 2019 and 2021. The investigation leads to the following main conclusions:

(i) There were 459 accidents in Hisar City throughout the five years between 2019 and 2023: 118 in 2019, 83 in 2020, 101 in 2021, 76 in 2022, and 81 in 2023.

(ii) Among 459 accidents that happened in Hisar City throughout the period, more than 18.3% resulted in fatalities, killing 90 people, and almost 73.4% caused injuries, injuring 240 people with light injuries and 246 people with severe injuries. The remaining 8.2% of accidents simply resulted in property damage.

(iii) According to the data, Motorcycle/ Scooty made up the largest percentage of accident fatalities (57.7%) and were followed in mortality rate by pedestrians (24.4%).

(iv) The road user's Car/van /ambulance was the most common. They caused more than 54.4% of all road accidents (250 from 459), with Motorcycle/ scooties coming in second with 15.9% of all incidents. The majority of victims on the road were Motorcycle/ scooties (259 out of 459, or around 56.4% of all accidents). Pedestrians/handcarts came in second with 109 victims, or almost 23.7% of all accidents.

(v) The study shows that May, July, and April had the fewest incidents, while March, February, and August recorded the most accidents—49, 47, and 46, respectively. The rainy season from June to September and the Holi celebration season in February and March can be blamed for the increased number of accidents in Hisar City during those three months.

(vi) The study shows that the maximum number of accidents occurring on Wednesday is 17% and the minimum on Sunday is 2.6% due to public holiday of colleges and departments.

(vii) The sort of collisions that account for the most accidents (30%) is head-end collisions, followed by rear-end collision which accounts for more than 27% of accidents, followed by pedestrians hitting more than 20% of accidents, according to the study of accident data.

(viii) The data of accidents caused in Hisar City from 2019-3023 shows that the maximum number of accidents that occur due to negligence, and Overspeed is more than 50% followed by carelessness, negligence is more than 13% of total accident data. Overspeed plays an important role in more than 60% of accidents due to this.

(ix) Consequently, Hisar City, Haryana, India has been found to have 18 blackspots; 4 of these are on Rajgarh Road, 4 are on Sirsa Road, and 2, 2, 2, are on Hisar-Delhi Bypass, Hisar Ghursal Road, Mall Road, and other roads are defined below with black spot locations.

(x) The top ten blackspot locations are *Gangwa (Hisar Rajgarh Road), Bus Stand (Sirsa Road), Sector 14 (Sirsa Road), South Bypass Sector 16/17 (Hisar Southern Bypass), Dabra Chowk (Mall Road), Near MG Club (Hisar Dehli Bypass), New Sabzi Mandi (Raipur Road), Sirsa Chungi (Hisar Delhi Bypass), Azad Nagar (Hisar Rajgarh Road), Rajgarh Road Naka (Hisar Rajgarh Road).*

Conclusion: The investigation of Blackspot in Hisar City shows that signal lighting not working, no crossing is available, no traffic police for manual guiding, and the brigades are not properly used. There is no pedestrian crossing, no road marking, and improper roadside parking. There is no median between two lanes of road, vehicles are overtaking in opposite lanes, restricted overtaking zones are not available, and reflecting lights or paint on side brigades are not available.
The remedial measures suggested for the top ten blackspot locations in Hisar City are providing pedestrian crossings for the safety of pedestrians, reflected strips/paint and speed breakers constructed for Azad Nagar main road, maintaining the pavement marking from time to time, maintenance of signal lights, traffic police for regular checking, proper street lighting for night accident reduction, maintaining of median and brigades, filling patch holes, maintenance of pavement surface, and shoulders.

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