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Accident Analysis and Improvement Measures on National Expressway 1

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Abstract: The Ahmedabad–Vadodara Expressway (NE-1) is one of Gujarat's most important roadways, offering fast and direct connectivity between two of the state's major cities. Although the expressway was constructed with modern engineering standards and safety features, a troubling pattern of traffic accidents has emerged over the past several years. This research investigates crash occurrences on NE-1 between 2017 and 2024, with the aim of identifying sections of the roadway that pose higher risk to travelers — commonly referred to as blackspots. The analysis draws on accident reports filed at local police stations and traffic volume records collected from toll booths along the corridor. Several evaluation methods were applied, including the Weighted Severity Index (WSI), Severity Index (SI), Average Annual Total Crash (AATC), Accident Severity Index (ASI), and GIS-based heatmap analysis. From this assessment, thirteen distinct blackspot locations were pinpointed. Contributing factors behind these incidents ranged from over-speeding and tyre blowouts to driver exhaustion, poor adherence to lane discipline, and unregulated vehicle entries. In response to these findings, the study proposes a series of targeted interventions that align with IRC: SP:131-2022 guidelines. These include road geometry improvements, speed management, better signage, measures to control stray animals, and initiatives aimed at educating drivers. The recommendations are intended to significantly reduce the severity and frequency of accidents across the NE-1 route.

Index Terms - NE-1 Expressway, crash-prone locations, accident trend analysis, expressway safety, severity-based indexing (WSI), IRC: SP:131-2022 guidelines, highway safety strategies.

I. INTRODUCTION

Efficient road infrastructure is a cornerstone of any nation's development, supporting the movement of people, goods, and services while strengthening both economic and social growth. In India, roads are not only crucial for connectivity between cities and villages, but they also play a key role in job creation and industrial expansion. Although National Highways (NHs) make up only about 2% of the country's total road length, they handle more than 40% of its traffic, underscoring their immense importance in the transportation system. In recent years, India has made strides in building access-controlled expressways designed to improve travel time and reduce congestion. While these roads enhance mobility and efficiency, they also introduce new safety concerns due to their high-speed nature and mixed traffic behavior.

The Ahmedabad–Vadodara Expressway, formally known as National Expressway 1 (NE-1), stands out as the country's first expressway and serves as a major link in Gujarat's transport network. Covering 93.1 kilometers, it connects two of the state's busiest cities and supports industries like pharmaceuticals, textiles, and manufacturing. Built with modern features such as grade-separated interchanges, crash barriers, underpasses, and regulated access, the expressway was intended to provide both safety and speed. However, in practice, the corridor has witnessed a disturbing rise in road crashes, many of them severe. This trend mirrors a larger national issue. According to the Ministry of Road Transport and Highways, over 461,000 accidents and around 168,000 road fatalities occurred across India in 2022 alone. Such statistics highlight the urgent need for stronger safety strategies and data-informed policy measures.

The situation on NE-1 reflects this urgency. Reported incidents range from high-speed collisions and tyre-burst-induced rollovers to fatal crashes involving parked vehicles. One particularly tragic event involved a speeding vehicle crashing into a stationary oil tanker, drawing widespread attention and calls for improved safety enforcement. Although authorities like the National Highways Authority of India (NHAI) have introduced basic interventions — such as rumble strips and clearer lane demarcation — the continuing occurrence of serious accidents signals the need for deeper analysis and more focused solutions. This research attempts to bridge that gap by examining accident data along the NE-1 corridor. It applies a suite of analytica methods, including the Weighted Severity Index (WSI), Severity Index (SI), Average Accident Cost Technique (AACT), and GIS-based heatmap analysis, to identify and study high-risk zones, or blackspots. The focus is not on predictive modeling, but on understanding crash patterns and root causes. The ultimate goal is to develop site-specific, evidence-backed recommendations to help road agencies, planners, and policymakers make this critical expressway safer for everyone.

II. LITERATURE REVIEW

Several researchers in recent years have addressed the rising concerns of road accidents, particularly on high-speed highways and expressways. Their work offers useful insights into blackspot identification methods and the effectiveness of remedial actions under varied traffic and roadway conditions.

Raviraj Ramesh Sorate et al. (2015) examined the critical role of national highways in regional development while also raising alarm over their high accident rates. To tackle rural highway crashes, the Accidental Prevention Committee (APC) was introduced in 1997. Their research, focused on NH-9 and the Mumbai–Pune Expressway, used a parameter-based ranking approach to detect accident-prone locations. The authors emphasized that while multiple criteria can help flag blackspots, a more in-depth, factor-wise analysis is essential to meaningfully reduce accident severity.

Athira Mohan et al. (2017) explored crash-prone zones along the Amravati–Nagpur section of Asian Highway 46. Using the Weighted Severity Index (WSI), they ranked locations based on crash impact and identified the five most critical ones as blackspots. Key issues noted were poor road markings, illegal roadside parking, and behavioral concerns such as helmet non-compliance and overspeeding among two-wheeler riders. The study highlighted the importance of reliable data in applying WSI effectively.

Parth B. Parmar et al. (2018) turned their attention to Ahmedabad's Sardar Patel Ring Road, employing GIS tools and field-based crash data. Their analysis led to the identification of 18 blackspots, with a notable vulnerability among two-wheeler users and pedestrians. Factors such as faded signage, worn pavement markings, and unsafe pedestrian zones were identified. Their suggestions included better enforcement, upgraded signage, pedestrian pathways, and nighttime safety measures.

Rejoice Bhavsar et al. (2020) utilized a statistical modeling approach — the Generalized Linear Model (GLM) — to evaluate safety on multilane rural highways. By analyzing crash data against variables like junction spacing, settlement proximity, average daily traffic, and travel speed, they demonstrated the potential of localized predictive models. They also used association rule mining to detect frequent crash scenarios, enabling more targeted countermeasures.

Mayura Yeole et al. (2021) introduced Artificial Neural Networks (ANN) into crash prediction research on the Mumbai–Pune Expressway. Their model, trained on data from 2016 to 2020, achieved an impressive accuracy rate of 99.7%. The study pinpointed sharp curves and excessive speed as major contributors to crashes, and argued for the adoption of AI tools in crash prevention and real-time risk management.

Ajit Bhadade et al. (2022) studied crash hotspots along BG Road in Assam, looking at road geometry, signage, and overall roadway design. Using police FIRs and IRC standards, they recommended infrastructure upgrades such as intersection redesign, better warning signs, and structured follow-up after accidents to prevent recurrence.

Saurabh Kumar S et al. (2022) carried out a road safety audit on NH-5 in Himachal Pradesh using ViDA software by iRAP. Their findings pointed to high risks for non-motorized road users, especially due to issues like poor visibility, inadequate pedestrian zones, and roadside encroachments. The study emphasized both design improvements and public awareness programs, particularly in hilly terrain areas.

P. Kumar et al. (2022) focused their work on accident prediction models (APMs) for expressways. They observed that many models from developed countries do not transfer well to Indian traffic environments due to differing vehicle mixes and behaviors. The authors found non-parametric models to be more flexible but highlighted the need to include variables such as lighting, pavement quality, and driver fatigue for Indian expressway conditions.

Laxman Singh Bisht et al. (2022) used a Random Parameter Negative Binomial (RPNB) model to examine crash patterns on an Indian intercity expressway. Their study noted that rear-end and single-vehicle crashes were dominant, especially during nighttime and on geometrically complex segments. By accounting for hidden factors through statistical heterogeneity, their work offered improved crash prediction and design-based interventions for semi-rural areas.

Umang Champaklal Modi et al. (2022) emphasized the value of integrating road safety audits into every stage of infrastructure development. They advocated for standardized checklists, enhanced pedestrian infrastructure, better lighting, and clearer road markings. Their central argument was that safety audits should be a routine part of planning and maintenance rather than a reactive measure.

Xinyu Liu et al. (2024) contributed a global perspective by studying crash data from 2012 to 2018 on the Hunan Expressway in China. Their findings showed that speeding and driver fatigue were leading causes of accidents, even as enforcement on other violations had improved. The study concluded that controlling driver behavior remains a major challenge worldwide and called for international cooperation in developing safer expressway practices.

III. OBJECTIVES OF THE STUDY

- To analyze past accident records in order to uncover patterns related to how often crashes occur, how severe they are, and where they are most commonly concentrated along the expressway.
- To explore the underlying causes of accidents, with a focus on examining the roles of driver behavior, road geometry, vehicle types, and environmental conditions in contributing to crash events.
- To identify and evaluate high-risk segments (blackspots) on NE-1 by applying analytical tools such as the Weighted Severity Index (WSI), Severity Index (SI), Average Accident Cost Technique (AACT), and spatial heatmap analysis using geographic information systems (GIS).

IV. METHODOLOGY

The methodology followed in this study comprises four key stages, as illustrated in the flow diagram. First, the **study area** is defined, focusing on the Ahmedabad–Vadodara Expressway (NE-1), which spans 93.1 km across major districts of Gujarat. Next, in the **data collection** phase, two primary types of data were gathered**: traffic volume data** from toll plazas and **accident data** from police FIRs. These datasets include information on vehicle classifications, accident types, time, location, and possible causes. The third stage involves **data analysis**, where analytical techniques such as WSI, SI, AATC, and ASI were applied to identify accident-prone zones. Finally, the findings were compiled and interpreted in the **result and conclusion** phase to suggest effective remedial measures for enhancing road safety on NE-1.

V. STUDY AREA PROFILE

This study is centered on the Ahmedabad–Vadodara Expressway (NE-1), a crucial roadway that stretches about 93.1 kilometers and connects key districts in Gujarat: Ahmedabad, Kheda, Anand, and Vadodara. As a vital transportation route for both passengers and freight, it serves as a major part of the Delhi–Mumbai Industrial Corridor (DMIC), significantly improving regional connectivity and contributing to the economic development of the area. NE-1, India's first access-controlled expressway, was inaugurated in 2003 with the aim of reducing congestion on National Highway 8 and drastically cutting down travel time between Ahmedabad and Vadodara.

Figure 4.1 National Expressway 1

CITY	CHAINAGE
Ahmedabad	0.000- 16.900
Kheda	16.900-52.940
Anand	52.940-75.635
Vadodara	75.635-93.102

The expressway features four lanes with a central median, alongside essential infrastructure such as toll plazas, interchanges, service roads, and crash barriers. Despite these advancements, the expressway faces increasing challenges due to growing traffic volumes and a rising number of road accidents. This has highlighted the need for thorough safety assessments and the identification of accident hotspots, or blackspots, along the route. To gather the necessary data for this research, accident records were collected from various points along the expressway, sourced from local police stations and the National Highways Authority of India (NHAI). The study covers the entire length of NE-1 for blackspot identification and trend analysis.

Geographically, NE-1 traverses a diverse range of landscapes, including urban, semi-urban, and rural zones. It begins near CTM in Ahmedabad (23°04'35.8"N, 72°39'07.6"E) and ends at Sama in Vadodara (22°21'58.2"N, 73°11'22.8"E), with an average elevation of around 48.77 meters above sea level. The expressway passes through a variety of land uses, such as agricultural fields, industrial areas, and densely populated urban spaces. The region experiences a semi-arid climate with three main seasons: hot summers (March to June), monsoons (June to September), and mild winters (November to February). Summers are often extremely hot, with temperatures ranging from 36°C to 41°C, which can contribute to pavement damage and tire-related failures. The monsoon season, characterized by heavy but intermittent rainfall, increases the risks of waterlogging, reduced visibility, and hydroplaning. Winter conditions are milder, presenting fewer challenges to road safety. These climatic factors significantly influence road conditions and accident risks, making them an essential aspect of the safety analysis.

Given its geographical importance, NE-1 serves as a key corridor connecting major urban centers and supporting the region's industrial, agricultural, and tourism activities. The growing traffic volume, coupled with varying environmental conditions, underscores the necessity of this study. The goal is to identify the critical safety issues on the expressway and propose targeted solutions to reduce accidents and improve overall road safety along this vital corridor.

VI. DATA COLLECTION

5.1 Accident Data

Accident records spanning from 2017 to June 2024 were collected from First Information Reports (FIRs) registered at police stations situated along NE-1. The data underwent processes of cleaning, validation, and structuring to prepare it for comprehensive analysis. Key parameters considered include the type of accident (fatal, grievous injury, minor injury, non-injury, and animal-related incidents), types of vehicles involved, precise chainage locations, date and time of occurrence, and identified causes (such as human error, mechanical failure, and environmental factors).

The dataset was further classified based on accident characteristics, temporal patterns (day/night, monthly, and yearly trends), causal elements, and vehicle participation. Additional variables such as district association, expressway side (UP/DOWN direction), and the nature of incidents (e.g., overturning, skidding) were incorporated to facilitate detailed spatial and severity-focused analyze.

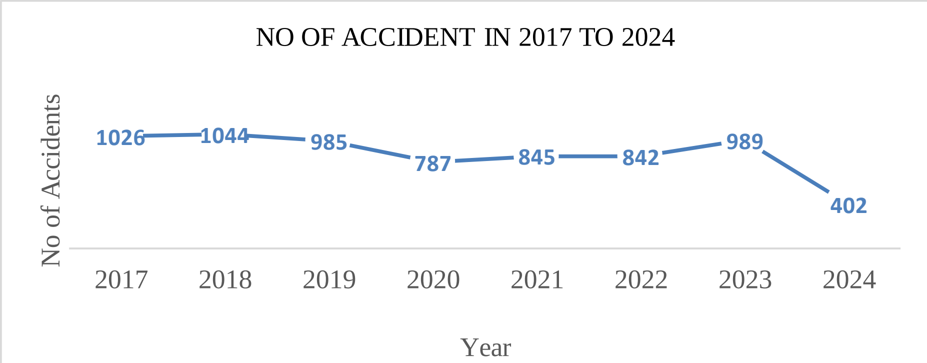
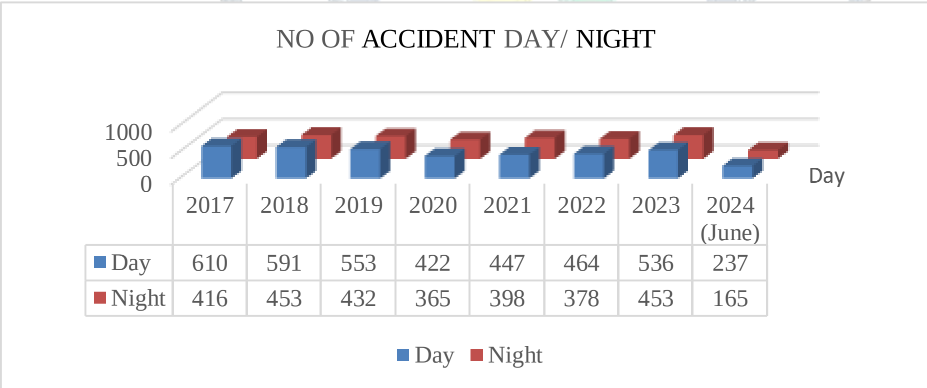


Figure 5.1 Yearly Accident Trends (2017-2024 (June))



	2017	2018	2019	2020	2021	2022	2023	2024 (June)
Day	610	591	553	422	447	464	536	237
Night	416	453	432	365	398	378	453	165

Figure 5.2 No of Accident in Day / Night (2017 to 2024)

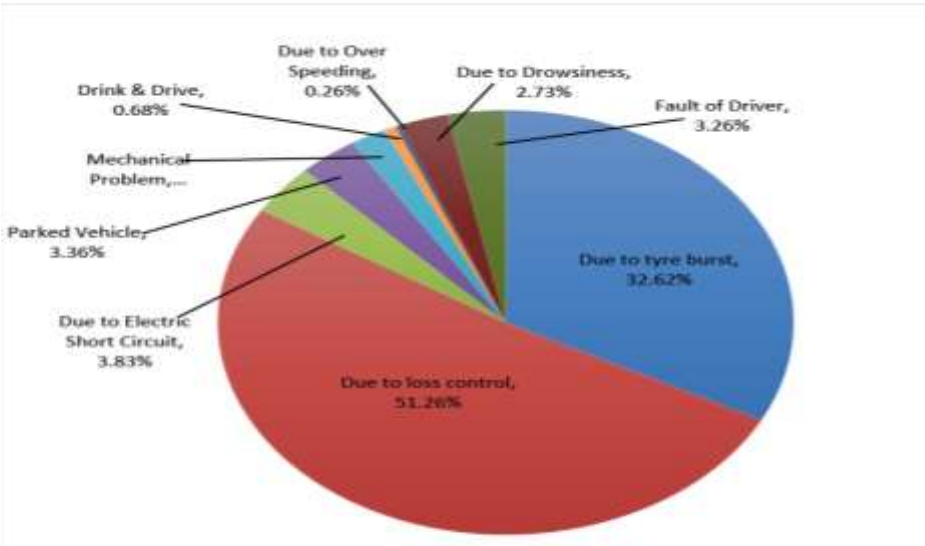


Figure 5.3 Percentage of Causative Factors for the Road Crashes. (2017 to 2024

5.2 Traffic volume data

Traffic flow data was gathered between September 16 and 22, 2023, from toll plazas at CTM, Nadiad, Anand and Vadodara. The dataset includes daily vehicle volumes, directional movements (UP/ DOWN traffic) and vehicle classification categories, namely passenger cars, light commercial vehicle (LCVs) and Heavy Commercial vehicles (HCVs).

Chainage	Toll Plaza	Car/ Jeep (%)	Mini Bus (%)	Bus (%)	Tempo /LCV (%)	2 Axle (%)	3 Axle (%)	M Axle (%)
2+600	Ahmedabad	72.10	0.34	10.71	9.80	2.01	1.32	3.69
43+300	Nadiad	65.14	0.29	5.45	11.02	6.05	2.80	9.25
58+600	Anand	60.54	0.18	5.20	17.44	6.37	3.89	6.35
86+600	Vadodara	61.42	0.17	5.15	16.87	6.35	3.91	6.09

Table 5.1 Vehicle composition Ahmedabad to Vadodara (NE 1) (16 to 22 sept 2023)

Chainage	Toll Plaza	Car/ Jeep (%)	Mini Bus (%)	Bus (%)	Tempo /LCV (%)	2 Axle (%)	3 Axle (%)	M Axle (%)
86+600	Vadodara	54.61	0.22	4.68	14.66	5.06	4.82	15.94
58+600	Anand	61.42	0.18	5.16	16.88	6.36	3.92	6.09
43+300	Nadiad	65.41	0.27	5.42	11.29	5.67	2.79	9.16
2+600	Ahmedabad	72.71	0.36	10.51	9.77	1.94	1.33	3.38

Table 5.2 Vehicle composition Vadodara to Ahmedabad (NE 1) (16 to 22 sept 2023)

VII. DATA ANALYSIS

A multi-method framework was adopted to identify accident-prone sections along the Ahmedabad–Vadodara Expressway (NE-1). Five key analytical techniques were utilized: Weighted Severity Index (WSI), Severity Index (SI), Average Annual Total Crash (AATC), Accident Severity Index (ASI), and Heatmap Analysis. Each methodology contributed distinct perspectives on crash severity, frequency, and spatial distribution patterns across the expressway.

1. **Weighted Severity Index (WSI)**: This method is a quantitative approach used to identify accident-prone locations by giving severity-based weights to different types of crashes. Fatal = 41, grievous = 4, and minor = 1 accidents are weighted respectively, emphasizing the higher impact of fatal crashes. The WSI for each segment is calculated as:

$$\mathbf{WSI = (41 * Fatal + 4 * Grievous + 1 * Minor)} \quad \text{…………………………………………………… (1)}$$

In this study, the Ahmedabad–Vadodara Expressway (NE-1) was segmented into 187 stretches of 500 meters, and WSI was computed for each segment using accident data from 2017 to 2023. Segments with WSI > 40 were classified as blackspots. This method effectively prioritized high-severity zones, aiding in the targeted deployment of road safety interventions.

2. **Severity Index (SI):** In this study, the Severity Indices (SI) method, are recommended by **IRC:131-2022**, was applied to prioritize blackspots based on the crash severity. A **Crash Severity Index (CSI)** was computed for each segment using weighted scores: Fatal = 10, Major injury = 5, Minor injury = 2, and No injury = 1, based on crash data from **2021–2023**.

The stepwise process I followed for determining the TCSI value includes:
Computation of Mean Severity Index (MSI) and Standard Deviation (SD):

The Mean Severity Index (MSI) was determined using Equation (2):

$$\mathbf{MSI = \sum xi/n} \quad \text{…………………………………………………… (2)}$$

where ‘**xi**’ represents the CSI value of a road segment, and ‘**n**’ is the total number of segments.

$$\mathbf{SD = \sqrt{\frac{(xi - MSI)^2}{n-1}}} \quad \text{…………………………………………………… (3)}$$

The Standard Deviation (SD) was then computed to assess data dispersion.

Calculation of TCSI Using the Normal Distribution Method:

The TCSI was derived using Equation (4):

$$\mathbf{TCSI} = \mathbf{MSI}(\mathbf{z} * \mathbf{SD}) \quad \text{………………………………………………………………………………… (4)}$$

where '**z**' is the z-score corresponding to the desired confidence level.
For a 95% confidence level, a z-score of **1.65** was utilized, ensuring identification of extreme severity values.

Based on TCSI:

- **First-order blackspots**: CSI ≥ TCSI (z = 1.65)
- **Second-order blackspots:** CSI ≥ TCSI (z = 1.29)
- **Third and fourth-order**: Identified with lower z-scores

Application to NE-1:

- 90 of 187 segments identified as **First-order blackspots**
- 97 segments identified as **Second-order blackspots**

3. **Average Annual Total Crash (AATC):** The **AATC method** identifies blackspots based on the **average crash rate** across 500-meter segments, considering traffic patterns, road geometry, and user behaviour across National Expressways (NE), Highways (NH, SH), and Other Roads (OR).

AATC Calculation Steps:

- Road divided into **500-meter** segments.
- Fatal crash data collected for **2021–2023**.

Compute **AATC/km** using the formula:

$$\mathbf{AATC} = \frac{\mathbf{Total\ Fatality\ over\ 3\ year}}{\mathbf{3}} / \mathbf{0.5} \quad \text{………………………………………………………………………… (5)}$$

Compute **AATC/500m** using the formula:

$$\mathbf{AATC\ 500m} = \mathbf{AATC/2} \quad \text{……………………………………………………………………………… (6)}$$

Blackspot Classification (Gujarat):

- First-order: AATC/500m > 6.45
- Second-order: 4.30–6.45
- Third-order: 2.15–4.30
- Fourth-order: 1.29–2.15

The **Ahmedabad-Vadodara Expressway (NE-1)** for the period from **2017 to 2019**, 2020 to 2022 and 2021 to 2023 a total of **13 blackspots** were identified from **187 segments**.

4. **Accident Severity Index (ASI)**: The ASI is a statistical measure used to evaluate accident-prone locations based on the severity of crashes. It assigns different weights to fatal and grievous accidents, ensuring that locations with more severe accidents receive higher priority for safety interventions.

Step of Blackspot Identification:

$$\mathbf{ASI} = (\mathbf{Fatal} * \mathbf{7}) + (\mathbf{Grievous} * \mathbf{3}) \quad \text{…………………………………………………………………… (7)}$$

- Fatal = Number of fatal accidents
- Grievous = Number of grievous (serious injury) accidents
- 7 = Weight assigned to fatal accidents3 = Weight assigned to grievous accidents

$$\mathbf{SD} = \sqrt{\frac{(\mathbf{ASI} - \mathbf{AVG\ ASI})^2}{\mathbf{n-1}}} \quad \text{......} \quad \mathbf{(8)}$$

- ASI = Accident Severity Index for each location
- AVG ASI = Average ASI across all locations
- n = Number of Segment

$$\mathbf{Threshold\ Value} = \mathbf{AVG\ ASI} + \mathbf{1.5}\ (\mathbf{SD}) \quad \text{......} \quad \mathbf{(9)}$$

- AVG ASI = Average ASI value
- SD = Standard deviation
- 1.5 = Statistical multiplier to set the threshold

Blackspot Identification: Chainages with a **Threshold Value** > **Threshold Avg** were classified as black spots.

The **Ahmedabad-Vadodara Expressway (NE-1)** for the period from **2017 to 2019**, 2020 to 2022 and 2021 to 2023 a total of **16 blackspots** were identified from **187 segments**.

The Average Threshold Value is 25 in the NE1 calculations.

5. **Heatmap:** The heatmap analysis was carried out using **QGIS 3.34.13** based on **accident records** with latitude and longitude coordinates. Linear referencing techniques were used to map crashes along the corridor. The **Heatmap Plugin** created a visual density map, showing accident intensity with a color gradient (blue to red). **Google Street Map** was used as the base layer for real-world visualization.

Figure 6.1 Accidents Heatmap

Figure 6.2 Fatal Accidents Heatmap

Figure 6.3 Visualization of Blackspot Coordinates on Map & Satellite View- NE-1 Corridor

District	Road Length	Village	Latitude	Longitude	Aatc	Si	Wsi	Asi
Ahmedabad	03+500 to 04+000	Ramol	22.97152	72.65795	✓	✓	-	✓
	07+000 to 07+500	Vanch	22.95531	72.68719	✓	✓	✓	✓
Kheda	23+000 to 23+500	Mankva	22.86532	72.80556	✓	✓	✓	✓
	25+000 to 25+500	Mankva	22.84919	72.81444	✓	-	✓	✓
	31+000 to 31+500	Vemali	22.80008	72.83886	✓	✓	-	✓
	35+500 to 36+000	Arera	22.76212	72.85464	✓	✓	-	-
	45+000 to 45+500	Salun Vanta	22.68988	72.90281	✓	✓	-	✓
	47+000 to 47+500	Fatepura	22.67423	72.91251	✓	✓	-	-
Anand	65+000 to 65+500	Vaghasi	22.55194	73.02715	✓	✓	-	✓
	71+000 to 71+500	Vehrakhadi	22.50667	73.05892	✓	-	-	-
	73+000 to 73+500	Anklavdi	22.49058	73.06776	✓	✓	-	-
Vadodara	79+000 to 79+500	Dodka	22.46690	73.11455	✓	✓	-	✓
	88+000 to 88+500	Ajod	22.40051	73.16155	✓	✓	✓	✓

Table 6.1 Comparative Analysis of The Blackspot Identification Method

VIII. RESULT & CONCLUSION

The analysis of NE-1 (Ahmedabad to Vadodara) covering the period from 2017 to 2024 highlighted major accident patterns, identified key blackspots, and uncovered critical contributing factors. Although fatal and grievous accidents occurred less frequently, their impact was notably severe. Locations such as Mankva and Vaghasi emerged as high-risk zones, with frequent accidents attributed to overspeeding, tyre bursts, and driver fatigue, particularly during nighttime hours and the monsoon season. A significant number of these incidents involved heavy vehicles. Based on these findings, targeted remedial strategies aligned with IRC: SP:131-2022 guidelines were recommended, emphasizing improvements in road infrastructure, speed regulation, vehicle compliance enforcement, enhancement of emergency response services, and community-based awareness initiatives. Effective implementation of these measures is expected to substantially improve road safety and reduce accident rates along the NE-1 expressway.

Remedial Measures:

Location	Chainage	Issues	Remedies
Ramol	Ch. 03+500 to 04+000	Tyre bursts, illegal parking, dangerous overtaking	Overhead signage, no-parking zones with CCTV, highway patrol, overtaking regulation
Vanch	Ch. 07+000 to 07+500	Overspeeding at night, poor lighting, uncontrolled rural access	Prohibit pedestrian crossings, install streetlights, speed cameras, local awareness
Mankva	Ch. 23+000 to 23+500	Lack of overpass signage, sudden braking, truck parking on the roadway	Overpass warning signs, rumble strips, strict no-parking enforcement
Mankva	Ch. 25+000 to 25+500	Vehicle overturns on sharp curves, no crash barriers, driver drowsiness	Speed enforcement, driver rest areas, better median barriers, animal control
Vemali	Ch. 31+000 to 31+500	High-speed loss of control, drowsiness, animal crossings	Rumble strips, fencing for animals, safe distance markings
Arera	Ch. 35+500 to 36+000	Loss of control near over bridge, fatigue-related crashes	VMS signboards, crash barriers, fatigue monitoring AI systems
Salunvanta	Ch. 45+000 to 45+500	Speeding, drowsiness, tyre bursts, rear-end collisions	Speed enforcement cameras, drowsiness detection, stronger median barriers
Fatepura	Ch. 47+000 to 47+500	Speeding, tyre bursts, animal impacts	Speed cameras, animal fencing, better tyre safety checks
Vaghasi	Ch. 65+000 to 65+500	High-speed Lane changes, tyre bursts, illegal parking	VMS alerts, TPMS use, CCTV on emergency lanes
Vehrakhadi	Ch. 71+000 to 71+500	High-speed control loss, rear-end	Reflective Lane markings, impact

Location	Chainage	Issues	Remedies
		crashes, no emergency shoulders	attenuators, lighting improvements
Anklavdi	Ch. 73+000 to 73+500	Loss of control, tyre bursts, parked vehicle crashes	Crash barriers, median fencing, overtaking regulation, CCTV monitoring
Dodka	Ch. 85+500 to 86+000	Overspeeding, sudden braking, vehicle rollovers	VMS displays, advance curve warning signs, rumble strips before curves
Ajod	Ch. 93+000 to 93+500	Speeding near toll exit/entry points, merging conflicts	Merge Lane extensions, speed limit enforcement, dynamic traffic signage

Table 6.2 Blackspot-wise Accident Issues and Recommended Remedial Measures on NE-1 Corridor

REFERENCES

[1] Ajit Bhadade, Dr. Ishfaq Rashid Shaikh, Dr. P. L. Naktode “Preparation of Action plan for elimination of Accident at blackspot (A Case Study)” 2022, “International Journal of Scientific Research in Science, Engineering and Technology”

[2] Athira Mohan, Dr. V.S. Landge “Identification of Accident Black Spots on National Highway” 2020, “International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 4, April 2017, pp. 588-596 Article ID: IJCIET_08_04_066”

[3] G. Gururaj “Road traffic deaths, injuries and disabilities in India: Current scenario” 2008, “The National Medical Journal of India Vol. 21, No. 1, 2008”

[4] Laxman Singh Bisht, Geetam Tiwari, K Ramachandra Rao, Kumar Neeraj Jha “Exploratory assessment of road traffic crashes on the intercity expressway in India” 2022, “Article in Advances in Transportation Studies · November 2022”

[5] Mayura Yeole, Dr.R.K.Jain, Dr. Radhika Menon “Accident Prediction Model for Mumbai-Pune Express Way” 2021, “Vol. 6 No. 3 December, 2021 International Journal of Mechanical Engineering”

[6] P Kumar “Accident prediction modelling for expressways: a review” 2022, “IOP Conference Series: Materials Science and Engineering”

[7] Parth B. Parmar, A. A. Amin, Dr. L. B. Zala “Black Spot Analysis Using QGIS for S.P. Ring Road, Ahmedabad (Ch.:00.00 Km to Ch.: 76.30 Km)” 2018, “International Research Journal of Engineering and Technology (IRJET)”

[8] Raviraj RAMESH Sorate “Identification of Accidental Black spots on National Highways and Expressways.” 2015

[9] Rejoice Bhavsar1 & Amit Amin1 & Laxmansinh Zala1 “Development of Model for Road Crashes and Identification of Accident Spots” 2020, “International Journal of Intelligent Transportation Systems Research”

[10] Saurabh Kumar S1 and Sunil Sharma2 “Measuring the Level of Road Safety through Road Safety Audit and Star Rating Method – A Case Study from Himalayan Expressway” 2022, “IOP Conf. Series: Earth and Environmental Science”

[11] Swargam Sanmithra, Naveen Namala “Road Safety Audit of The Noida-Greater Noida Expressway” 2019

[12] Umang Champaklal Modi “Enforcement of Road Safety Audit and Road Engineering in India” 2022, “Proceedings of the 6th International Conference on Civil Engineering for Sustainable Development”

[13] Xinyu Liu, Shengjun Huang and Qun Chen “Cause analysis of expressway traffic accidents based on accident statistics of Hunan provincial expressway in 2012–2018”, “Transportation Safety and Environment, 2024, 6: tdad010 DOI: 10.1093/tse/tdad010”

[14] IRC:131-2022 – Guidelines for Identification and Treatment of Blackspots. New Delhi: Indian Roads Congress, 2022.

[15] CSIR - Central Road Research Institute. (2017). Indian Highway Capacity Manual (Indo-HCM), 2012–2017.

[16] SP:88-2019 – Manual on Road Safety Measures for Expressways and National Highways.

[17] Ministry of Road Transport and Highways (MoRTH) (2020). Government of India.

[18] SP:84-2019 – Manual of Specifications and Standards for Expressways.

[19] IRC: SP:99-2013 – Manual on Road Safety Engineering.