Identification of Accident Black Spots for National Highway Using GIS

Abstract-It is vital for individuals involved in developing policies in some nations with struggling economies to establish strategies that will guarantee that every dollar made accessible is used to advance the nation. To encourage an atmosphere favourable for economic development in those disciplines. Due to their enormous cost and resulting social and economic concern, road traffic accidents have been identified as one of those unfavourable factors that contribute to the stifling of economic progress in developing countries. Therefore, the growth of sustainable modes of transportation depends on traffic safety. The biggest negative effects of contemporary vehicle transport networks today are the harm and fatalities caused by accidents. The analysis of precise and trustworthy traffic accident data is crucial to the success of traffic safety and highway improvement programmes. This paper discusses the current state of data on traffic accidents along NH-58 in Uttarakhand State, which runs from Meerut to Muzaffarnagar. Additionally, it will go through how to identify high accident-rate locations using GIS software and unsafe roadway zones. So, put in place the provisions for traffic safety as well as the corrective actions for those unintentional sites (Black Spots).

1. INTRODUCTION

The need for solutions or alternatives that provide effective, safe, practicable, and quicker modes of transportation has grown significantly due to the globalisation of the transportation issues experienced by numerous nations. According to estimates, India is currently responsible for close to 10% of all fatal road accidents worldwide. Additionally, every year more than 1.3 million people in India suffer major injuries on the roadways. As a result, officials are now quite concerned about road safety.
The growth of the urban transport system has not kept up with the quality and quantity of traffic demand. Because of this, the usage of individualised transportation, mostly two-wheelers and intermediate public transportation, is expanding quickly.

The growing issue of congestion in metropolitan areas is largely due to the disproportionate growth in traffic compared to the expansion in road length, as well as unpermitted encroachments on road space, a lack of traffic and lane discipline, and flaws in traffic control.

Accident analysis can benefit greatly from the developments in GIS and GPS.
Despite being in use for more than 30 years, GIS has just lately been applied to the transportation industry. GIS is able to manage and visually display a variety of data kinds for simple interpretation in addition to encouraging connectivity between various forms of data and maps. GIS is a tool for organising and analysing geographic data.

It visually presents the findings from analyses, enabling complex analysis and rapid decision-making. To increase the

efficiency and effectiveness of traffic accident countermeasures, a system that employs GIS to analyse traffic accidents has been developed. Additionally, GIS would speed up and simplify analysis, which otherwise would be quite labour-intensive. As a result, GIS will provide a platform for maintaining and updating accident record databases and using them for additional analyses.

2. STUDY AREA

In the Indian states of Uttara Pradesh and Uttarakhand, respectively, are the districts of Meerut and Muzaffarnagar. The district's administrative centre is located in the town of Muzaffarnagar, which also serves as its name. Haridwar District and Meerut District form the northern and southern boundaries of Muzaffarnagar District, respectively.
The growth of new educational institutions in Roorkee, the development of Haridwar and Rishikesh as significant tourist attractions, and other industrial expansions have boosted demand for traffic on National Highway-58. Numerous festivals, including the MahaKumbh and ArdhKumbh in Haridwar, draw an excessive number of people, resulting in traffic gridlock. When it rains, followers of Lord Shiva (Karwaria) gather water in Haridwar and travel by foot to Pura Mahadeo in Meerut. For nearly a month, the Highway is scarcely used by vehicles. The 63 km long study area, designated as NH-58 (from Km 75 to Km 138), is located between 29° 0'00 and 30°5'00 North latitude and 77° 30'00 and 77° 45'00 East longitude.

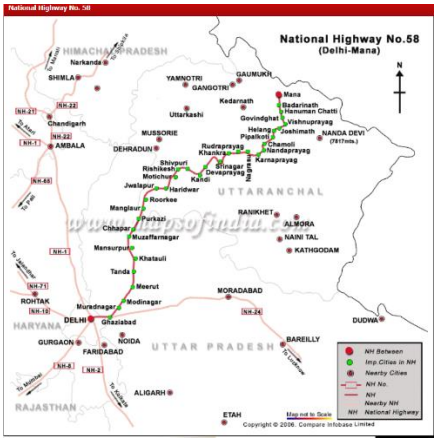

*Image showing NH-58 Map.

3. METHODOLOGY

a. Data Collection:
The following data were gathered and utilised to identify the accident-prone places in the Muzaffarnagar district.

1. Taken from the Office of the Super Indented Police's police stations limit map.
2. Accident statistics for 2007, 2008, 2009, 2010, and 2011.
3. Topological map of India, scaled at 1:50,000.

b. Collection of Ground Control Points:
With the aid of the GPS, the GCPs are gathered. Five GCPs have been gathered here. from the topo sheet survey of India at several road crossings.

c. Data processing:
The following three steps make up data processing. Figure following displays the data processing flow chart.

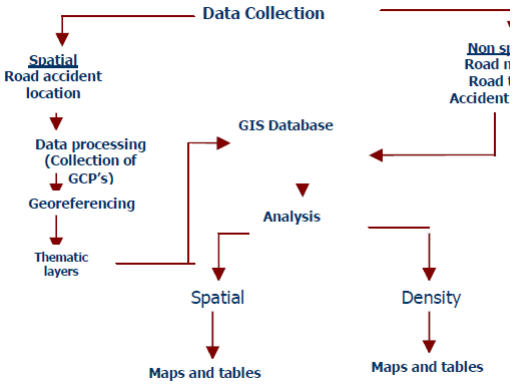

Figure 1- Methodology

d. Map Scanning:

The Survey of India topographical map at a sale of 1:1, 50,000 were scanned as the raster input.

e. Geo referencing:

Maps that have been scanned typically lack information about where the area depicted fits inside the earth's surface. Aligning or georeferencing the raster data is necessary to establish the correspondence between an image coordinate system and a map's (x, y) coordinate system.

f. Digitizing

Encoding geographic features as x, y coordinates in digital form is the process of digitising. It was done to convert hard copy maps and papers into spatial data. Arc GIS 9.3 is used in the current work to digitise the geo-referenced raster image of the Muzzaffanagar district. Onscreen digitising is the term used to describe this process. The research area's road network was digitised as line features. Accident sites are captured as point characteristics in digital form. The feature class and personal geo database used to organise the aforementioned geographic data. The'measure' tool in ArcGIS 9.3 was used to pinpoint the precise location of accidents. A specific accident's spatial position can be marked using the measure tool by knowing how far it is from a particular station. Figure 4 displays a map of the accident locations for the year 2011.

g. Assigning Attributes:

Separate attribute tables will be present for each type of vector data, such as line, polygon, and point features. Using the city map provided from the police station, each Road is given its matching name in this location. Similar information can be found in the accident location attribute table. These are shown below in figure 2.

1. User identification Number
2. Police Station Limit
3. Month of occurrence
4. Time of occurrence
5. Exact area of occurrence
6. Type of accident
7. Type of Injury
8. Type of vehicle involved

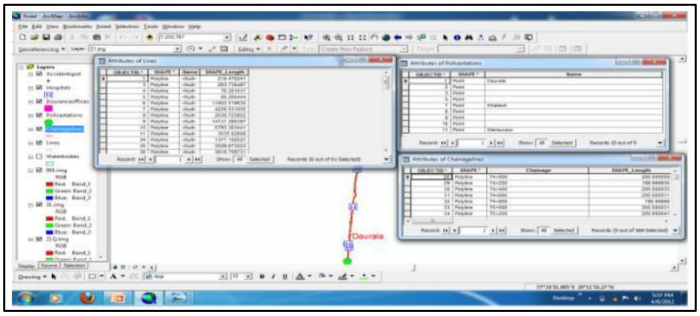

*Figure 2- Showing the Assigning Attributes

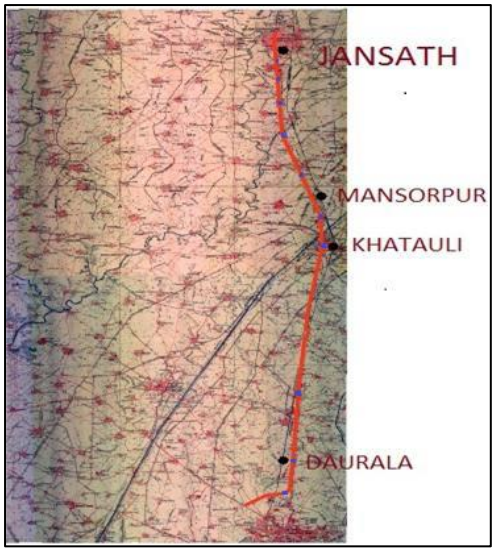

*Figure 3- Map Showing the accident Locations

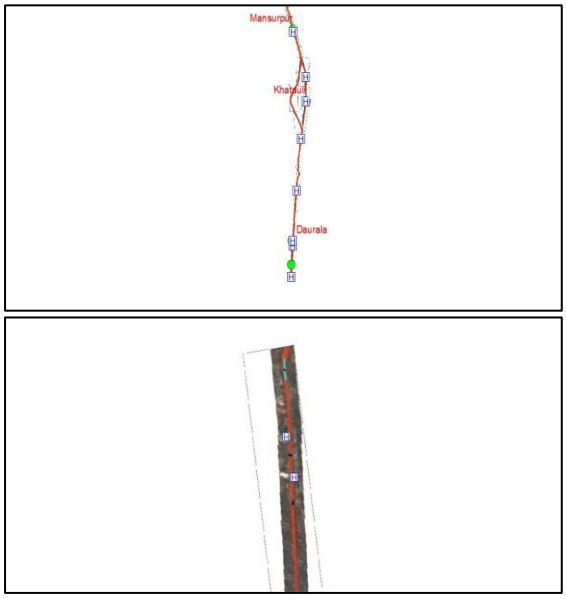

*Figure 3- Map showing the Accident location.

h. Identification of Black spots:
An accident black spot is a location, whether a link or a node, that has aberrant crash frequencies or rates. The Critical Crash Rate Factor Method is a method used in the study to determine dangerous Locations. It is impossible to pinpoint dangerous regions based just on the frequency of wrecks because traffic accidents are unpredictable occurrences that can be categorised as "Rare Events." Instead, to establish if the collision rate at a certain place is significantly greater than the average for the kind of facility, the critical rate technique takes into account the volume of traffic. An area is designated as an Accident Black Spot if its crash rate is significantly higher than the average crash rate for other areas within the jurisdiction with comparable characteristics.

Steps Involved are as followed:

i. Determination of the location's crash rate: It is decided based on exposure information, such as the volume of traffic and the length of the road portion under consideration. The number of collisions per 100 million vehicle kilometres of travel is known as the rate per 100 million vehicle kilometres (RMV). It results from expressiveness.

$$RMV = \frac{Ax100,000,000}{VT}$$

A= Number of crashes.

VT= Kilometres travelled by vehicle in given time period.

ADT=
(No. of days in study Period) x (No. of years) x (length of road segment)

ii. Determining the critical crash rate: The following expression is part of the

Critical Crash Rate Factor methodology:

$$CR = AVR + \frac{0.5}{TB} + TF\sqrt{AVR/}$$

CR- Critical Crash rate per million vehicle-km.

AVR- Average Crash rate for facility type.

TF- Test factor. (TF= 1.96 for 95% confidence level)

ADT= Average Daily Time

iii. Compare the crash frequency at the location to the critical crash frequency. Declare the area an Accident Black Spot if the crash rate is higher than the threshold. Accident Black spots are identified by using "Critical Crash rate factor method"

If the ratio of the section's crash rate to the critical crash rate of that particular type of facility is greater than 1.5, the place is identified in the current study as an accident black spot. In figure, a few accident locations are shown in figure-4

4. CONCLUSION

The following conclusions have been drawn from the current study:

1. On NH58 (from Km 75 to Km 138), the total number of crashes has tripled over the past five years (2007–2011).
2. The Critical Crash Rate Method is an easy-to-use statical test method, it is excellent at locating dangerous sections of four-lane highways.
3. Analysis shows that the majority of crashes happen on weekends, which may be related to the significant number of visitors visiting Haridwar and Rishikesh.
4. Analysis shows that the months of August and December have the highest number of crashes. This can be because of the beginning of the rainy season in august and because of the fog in December.
5. The peak time for Crashes turns out to be from 14:00 to 16:00.
6. The safety development programme can be prioritised using the crash ratio that was developed for the sections.

5. REFERENCES

1. Amira K. Al-Aamri, "Mapping Road traffic crash hotspots using GIS-based methods: A case study of Muscat Governorate in the Sultanate of Oman".
2. Prof. Molugaram Kumar, "Identification of Accident Black Spot Locations Using GIS & GPS Technology: A Case Study of Hyderabad"
3. Anitha Selvasofia.S.D, "IDENTIFICATION OF HOTSPOTS OF TRAFFIC ACCIDENTS USING GIS"
4. MITAL DAMANI, "Identify Hazardous Road Location for Road User Using GIS - Case Study of Rajkot"
5. https://www.mapsofindia.com/driving-directions-maps/nh58-driving-directions-map.html
6. https://morth.nic.in/
7. https://morth.nic.in/black-spot
8. https://morth.nic.in/sites/default/files/Uttar_Pradesh.pdf