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# ROAD ACCIDENT ANALYSIS USING Q-GIS AND ROAD SAFETY AUDITING

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**Abstract -** *This study aims to utilize Geographic Information Systems (GIS) to analyze and identify intersections with the hotspot identification, incorporating road safety auditing principles. By integrating spatial data on road accidents, traffic patterns, and various relevant factors, the Q- GIS approach provides a comprehensive framework for understanding and visualizing the spatial distribution of fatal accidents. The research involves collecting and processing data from multiple sources, including accident reports from police stations, significant road information of signs, markings etc. while also considering road safety auditing guidelines and practices. Through spatial analysis techniques such as hotspot analysis and network analysis, the study identifies high-risk intersections and assesses the factors*
*contributing to increased fatality rates, and suggest remedial measures.*

***Key Words***: Hot spot, Accident, Q-GIS, Signs and Markings, road safety.

## 1. INTRODUCTION

Accidents on roads pose a significant threat to public safety and can have severe social, economic, and environmental impacts. To mitigate these risks and enhance road safety, thorough accident analysis and road safety auditing are crucial. In recent years, Geographic Information Systems (GIS) software, particularly QGIS, has emerged as a powerful tool for analyzing and visualizing accident data. When combined with road safety auditing techniques, QGIS enables professionals to gain valuable insights into accident patterns, identify high-risk areas, and develop effective measures to prevent future accidents.

Accident analysis involves the systematic examination of road crashes, including their causes, contributing factors, and consequences. By analyzing accident data, transportation planners, engineers, and policymakers can identify patterns, hotspots, and trends that provide valuable information for improving road safety. QGIS, an open-source GIS software, offers a range of tools and capabilities to analyze accident data spatially. It allows professionals to map and visualize accidents, overlay them with other spatial data layers, and conduct spatial statistical analyses.

Road safety auditing complements accident analysis by providing a proactive approach to identifying potential safety issues and deficiencies in road design, layout, and infrastructure. Through comprehensive road safety audits, professionals can assess the safety performance of existing road networks or proposed design projects. These audits involve a systematic review of road geometry, traffic control measures, signage, pedestrian and cyclist facilities, and other factors that influence road safety. By conducting road safety audits, potential hazards and risks can be identified and remedial measures can be recommended to enhance safety.

### Need for study

Accident analysis is crucial for understanding the causes and factors contributing to road accidents. It helps identify patterns, trends, and specific areas of concern. By examining accident data, transportation professionals can assess road safety performance, determine the effectiveness of existing measures, and make informed decisions to develop targeted interventions. The insights gained from accident analysis aid in improving road safety, reducing accident rates, and enhancing transportation systems overall.

### Literature review

The extensive literature review was carried out by referring standard journals, reference books and conference proceedings. The major work carried out by the different researchers is summarized below.

1). Professor Leni Stephen et al The study focused on identifying and prioritizing accident-prone areas, also known as black spots, using an ArcGIS application. It involved conducting a thorough survey of various road characteristics such as width, shoulder, surface type and condition, obstruction, signage, drainage, and visibility. The analysis provided a zoomed-in view of the prioritized black spots and offered recommendations for addressing the issues at each identified location.

2). Ghulam ali shajabak hsh,et al In Mashhad city, Iran, a case study was conducted to investigate the impact of Jio information technology and spatial statistical analysis on road accidents. The objective was to conduct a comprehensive analysis, including examining factors such as

population density, nearest neighbor distance, K function analysis, and utilizing ArcGIS. The aim was to gain a deeper understanding of accidents in intricate urban networks. The study's final outcomes comprised analyses of accident patterns, examining the causes of fatalities, and prioritizing areas with high accident rates based on injuries and fatalities.

3) V.prasanna kumar et al An assessment was conducted in Thiruvananthapuram, a city in South India, which highlighted the issue of inadequate land development and transportation leading to congestion and accidents. The study utilized spatial clustering analysis and hotspot identification using ArcGIS, Moran's I method, GETIS OrdGI, and kernel density estimation to analyze accident patterns. The research specifically focused on accidents during both monsoon and non-monsoon periods, considering factors such as time, proximity to regions, and educational institutions. The study concluded by identifying different types of accidents based on temporal and spatial aspects. The results can be effectively utilized for traffic management and accident reduction strategies.

4) Ishan Crada et al. conducted a study to address a similar issue by proposing an approach that utilizes accident records while excluding factual and preventative information. The research focused on a case study in Pilam town, evaluating the variability of variables and analytical techniques in non-urban settings. Data collection was consolidated from hotspot areas and police stations, with hotspot areas chosen as a preferable option for data gathering. The study aimed to determine the best approach for analyzing the collected data and mapping accidents, employing various statistical and geographical analysis techniques, including separation, autocorrelation, and kernel density examination. GIS was utilized as a tool to enhance road safety.

5). Mohammad Bahar Ali Rabbani et al. conducted studies that employed spatial analysis and statistical methods to investigate the spatial distribution of local traffic accidents. The research focused on examining traffic collisions in the Moyatabad neighborhood of Peshawar. The main objective of the study was to utilize advanced statistical techniques to identify accident hotspots in the Nistal area using ARCGIS 10.2. A system was developed to analyze the spatial pattern of traffic accidents and identify hotspot clusters in ArcGIS. The study employed the NHA special color studying algorithm in CrimeStat and interpolation techniques such as Kriging, a geostatistical method. The results obtained suggest that illegal parking violations and traffic rule violations contribute to accidents in these hotspots, emphasizing the importance of enforcing traffic regulations.

6). In their study, Ibrahim Yilmaz et al. georeferenced tabular data related to highways within the administrative boundaries of Afyonkarahisar. They converted the text data into a tabular format and conducted investigations using two different methods of kernel density analysis. The study focused on identifying accident hotspots and examined the reliability of the method in reflecting problematic areas such as intersections and crossroads. Previous studies have primarily used GIS for visualization purposes, while this research delved into deeper analysis.

7). In this paper, Mazhar Sayed et al. described the utilization of Geographic Information System (GIS) and the development of a traffic plan. They aimed to enhance the Traffic Safety Audit process by employing GIS-based software called Gram++. The study focused on a 3-kilometer road segment along National Route 17, between Panvel and Iidapur. The researchers performed digitization of road features and created a database to facilitate analysis of the layered road segments in a systematic manner.

8. ). Kohinoor Kar et al. conducted a comprehensive study on Road Safety Audits (RSA) in various locations across Arizona. This paper presents an overview of the Arizona RSA program, highlighting the issues and recommendations identified by the researchers who have conducted numerous audits. The success rate of RSA in preventing accidents is noted to be better in many places across the United States and globally.

9). Sanjay Kumar Singh et al. conducted research on road traffic accidents in India, focusing on the issues and challenges at both national and state levels. The study analyzed data regarding fatal accidents, injuries, age and gender distribution, monthly and hourly patterns, and causes of accidents. The findings revealed that male fatalities were higher than female, accidents peaked in May, June, December, and January, and most accidents occurred between 9:00 AM and 9:00 PM. Driver faults accounted for 78% of the accidents. While road safety solutions may vary across states with high motorization rates, some fundamental principles remain the same, such as good road design, traffic management, improved vehicle standards, speed control, and the use of seatbelts, helmets, and alcohol limits

.10). Yannis George and his team conducted research to investigate the severity of road accidents based on vehicle types. They analyzed a dataset of 5931 recorded accidents and developed mathematical models using normal probability distribution. A total of 15 statistical models were created, one for each vehicle type and for each accident individually. The findings of the study have practical implications for improving road safety. Future research could explore additional parameters like road geometry, traffic conditions, and regional factors in Greece.

11). Tessa Anderson utilized kernel density estimation to identify hotspots of road accidents, but noted that the suitability of this method depends on the intended outcome. If the analysis focuses solely on road accident data, alternative methods may be more appropriate, given the range of tools available in ArcGIS.

12). MD Ali Aghajani et al. conducted a study on the incidence of accidents in provinces characterized by a mountainous climate and rainfall exceeding 500mm. The analysis of accident hotspots revealed that these regions

exhibit clustered concentrations, albeit with relatively lower weights.

13). Tummala Bhart Kumar et al. conducted a road safety audit to enhance road safety on NH 65. The study aimed to identify design flaws, accident-prone areas, and the impact of roadway geometry on the highway. The findings led to recommendations for improving road geometry, significant signage, and markings, as well as the provision of appropriate lighting for night travel.

14) Devang G Patel et al. conducted a road safety audit on State Highway 83 and State Highway 188, which are major highways in Gujarat connecting to NH 8 with high traffic volume. The study aimed to analyze the land use pattern, identify causes of accidents, and pinpoint major accident-prone areas. Through data collection and analysis, it was concluded that the main cause of accidents was driver error, along with factors such as poor road geometry, high traffic density, and environmental conditions. The researchers suggested remedial measures including implementing a proper licensing system and improving lighting to reduce these accidents.

15) Alvydas Pi Kunas et al. conducted an economic evaluation of road safety measures in Lithuania, considering the safety benefits and associated costs. They utilized a traffic planning process that encompassed various activities aimed at providing efficient transportation services while considering economic, social, and environmental factors. The study included the development of structural plans, transportation plans, area plans, and traffic management strategies. Additionally, a road safety audit was performed to assess existing road features at different stages and highlight their benefits. The overarching objective was to enhance road safety in Lithuania, which previously lacked a road safety auditing system.

## 2. Objectives

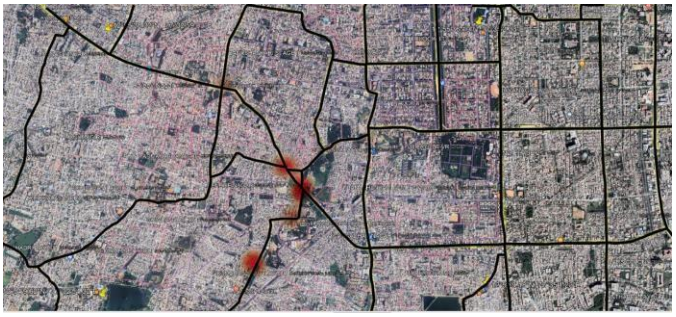
- The identification of blackspots and the analysis of accidents using QGIS involves examining accident data in order to identify areas with a high concentration of accidents.
- Investigate highway geometrics and silent features of road for accident reduction.

## 3. Methodology

Methodology for Accident Analysis using QGIS:

- Data Collection: Gather comprehensive accident data, including location coordinates, accident type, date and time, road conditions, and any other relevant variables. Obtain this data from reliable sources such as police reports, accident databases, or transportation authorities.
- Data Preparation: Clean and organize the accident data for analysis. Ensure that all necessary attributes are properly formatted and georeferenced. Convert the data into a compatible format (e.g., CSV, Excel) that can be imported into QGIS.
- Import Data into QGIS: Open QGIS software and import the accident data into a new project. Use the appropriate data import function or plugin to load the accident dataset. Ensure that the data is projected correctly onto the map canvas to enable accurate spatial analysis.
- Spatial Visualization: Create a base map using relevant spatial layers, such as road networks, intersections, and land use. Overlay the accident data onto the base map to visualize the distribution and density of accidents. Apply different symbology techniques to represent accident severity or types.
- Hotspot Analysis: Utilize QGIS tools to perform hotspot analysis, such as Kernel Density Estimation or Spatial Autocorrelation analysis. These tools identify clusters or concentration of accidents in specific geographic areas, highlighting potential high-risk zones.

Methodology for Accident Analysis using RSA (Road Safety Auditing):



- Utilizing the outputs from Q-GIS:
  - Determining the accident-prone areas.
  - Modelling a way to reduce the accidents
  - Providing a better experience to the road users which include students, office going people etc.

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RSA ( Road safety Auditing ) Finding:

Broken Divider

Risks

- Increased risk of head-on collisions
- Reduced lane discipline
- Confusion and uncertainty among drivers
- Impaired traffic flow
- Potential hazards for pedestrians and cyclists

remedies

- Prompt repair or replacement of broken dividers
- Use temporary measures such as cones, barriers, or signage
- Enhance visibility through reflective materials or additional lighting
- Increase law enforcement presence near broken dividers.

Traffic signs not visible

Risks

- Reduced visibility due to obstruction by covered sign boards
- Increased potential for driver confusion and disorientation
- Higher risk of incorrect manoeuvres or decisions by drivers
- Impaired ability to follow traffic signs, warnings, and instructions
- Elevated chances of accidents or collisions at intersections with covered sign boards
- Reduced effectiveness of traffic management and guidance systems

Remedies

- Regular maintenance and inspection of sign boards to ensure they are not covered or obstructed by any objects.
- Implementing a system for reporting and addressing covered sign boards promptly.
- Clear guidelines and regulations for sign board owners to ensure they maintain clear visibility of their signs.

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Potholes

Risks

- Potholes can cause tire punctures, wheel misalignment, and suspension damage.
- Hitting a pothole unexpectedly can momentarily affect a driver's ability to maintain control of the vehicle, potentially leading to accidents.
- Potholes on sidewalks or footpaths can cause pedestrians to trip or lose their footing, resulting in injuries.
- Potholes pose a high risk for motorcycles, bicycles, and scooters, leading to loss of balance and potential falls or collisions.

Remedies

- Regular road inspections and maintenance to identify and repair potholes promptly.
- Implementing proactive measures such as preventative maintenance techniques to minimize the formation of potholes.
- Establishing a responsive reporting system for potholes where citizens can report potholes to relevant authorities for quick action.
- Prioritizing high-traffic areas and roads with a history of pothole issues for timely repairs.
- Utilizing durable and long-lasting road construction materials to reduce the occurrence of potholes.

No Turning Markings at junctions

Risks

- Increased chances of accidents
- Confusion at intersections
- Reduced visibility at night or in adverse weather conditions
- Difficulty in maintaining proper speed limits

Remedies

- Implement clear and visible road markings
- Install appropriate signage
- Educate drivers
- Increase enforcement
- Enhance road infrastructure

## CONCLUSION

The combination of accident analysis using Q-GIS (Quantum Geographic Information System) and road safety auditing is a powerful approach to enhancing road safety. By leveraging the spatial analysis capabilities of Q-GIS, accident data can be effectively visualized and analyzed, allowing for a deeper understanding of accident patterns, and contributing factors.

Road safety auditing complements the analysis by evaluating the existing road infrastructure, identifying potential hazards, and suggesting improvements to enhance safety. The integration of these two methodologies provides a comprehensive understanding of road safety issues and

enables evidence-based decision-making for effective interventions.

The use of Q-GIS allows for the identification of accident-prone locations, such as intersections or road segments, enabling targeted safety audits. By assessing factors such as signage, road markings, visibility, and traffic flow, road safety auditors can identify deficiencies and propose measures to mitigate risks and improve overall safety.

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