Case Study On Analysis Of Road Congestion Considering Live Traffic Data

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Abstract- *In Indian cities, the need for transport has increased as a result of rapid urbanisation. When it comes to meeting the increasing travel demand, public transport has fallen short. Population profiling is increasing the number of people who own cars. On Indian city highways, congestion is caused by a significant number of private vehicles, a variety of traffic patterns, and a shortage of available road space. The metropolis of Bhopal is expanding quickly. Bhopal roads see considerable traffic due to a combination of a high demand for transit and a shortage of available road space. The majority of the population's access to transit services is becoming more difficult due to Bhopal City's explosive growth. The expanding traffic demand cannot be accommodated by the existing infrastructure. The purpose of this study is to examine how various factors that lead to traffic jams in cities interact with one another. Due to traffic congestion, a large portion of working hours is wasted on the roads, which negatively affects the economy as a whole. Numerous studies and works of literature have been devoted to the examination of congestion and its consequences. But the final result hasn't been good enough. The goal of the current study's congestion projection is to identify the underlying viability of the diversified traffic situation and offer better guidance for controlling and preventing these protracted traffic jams in mixed traffic with no lane discipline.*

Keywords: Congestion, Pause points, Intersection Congestion, Economy Impact, Impact To Environment, Impact To Health.

I. INTRODUCTION

Urban transport is a major problem in many Indian cities. Congestion, accidents, and pollution are issues that users must deal with despite expenditures in road infrastructure and framework plans for transport development. Particularly when national highways and other roads converge, accidents are a serious issue. A significant amount of time and fuel are frequently lost as a result of traffic congestion. Crossing the road might be inconvenient for pedestrians. Pollution rises as a result of traffic, and it has a negative impact on the health of nearby residents. Urban cities are experiencing a sharp rise in traffic delays and poor traffic management. Effective traffic movement monitoring and management are crucial for ensuring smooth vehicle flow and for overcoming the many obstacles. The substantial volume and makeup of intercity traffic in Bhopal define the city's traffic patterns. Many transportation issues are currently plaguing the city, including traffic jams, parking issues, narrow roads, heavy delays at signalised junctions, accidents, and poor mass transit infrastructure.

TRAFFIC CONGESTION

A transportation phenomenon known as traffic congestion is defined by longer journey times, slower vehicle speeds, and more cars in queues on road networks. The smooth flow of traffic breaks down when the amount of traffic exceeds the capacity of the road. Traffic congestion can take the form of stop-and-go traffic, protracted delays, or in extreme situations, a total halt known as gridlock or traffic jams. Reduced average speeds, longer travel times, noticeable lines at bottlenecks like crossroads or lane restrictions, and frequent cycles of braking and acceleration are all common signs of congestion. The issue is caused by an imbalance between the capacity of the roads and the demand for traffic, which is influenced by a number of factors, including excessive traffic volumes, physical road restrictions, traffic incidents, and ineffective traffic management. Air pollution, higher fuel usage, traveller stress, and lost productivity are just a few of the substantial social, economic, and environmental consequences associated with congestion. From an academic standpoint, traffic congestion is viewed as a dynamic, complex system state that results from the nonlinear interplay of human behaviour, infrastructural constraints, and vehicle flow within transportation networks. It is crucial to comprehend its causes and traits to create efficient plans for infrastructure and urban mobility management.

Fig 1: Traffic Congestion

OBJECTIVES OF THE RESEARCH

- Identify the capacity of Rotary Intersection.
- To provide suggestions for modification of rotary intersection if required.
- Identify the reasons for Road congestion.
- Understand the geography of the case study using GIS.
- To develop prediction model of vehicle movements.
- The analysis and the outcome will substantially replicate the traffic behavior on case study intersection.

II. REVIEW OF LITERATURE SURVEY

Rohit Katiyar et.al (2025) The goal of the study is to improve the efficiency and safety of transportation by examining traffic flow, pedestrian mobility, and the built environment at Bittan Chouraha, a crucial intersection in Bhopal. Rapid population expansion, urbanisation, industrialisation, and better living conditions are the driving forces behind this study, which aims to pinpoint important areas of congestion, examine accident data and crash places, and carry out thorough evaluations of both pedestrian and vehicular traffic. Furthermore, through surveys, user experiences and public perception will be integrated to offer thorough information for creating efficient traffic management plans.

In order to reduce traffic at Bittan Chouraha, the study ends with a number of recommendations. These include building a bridge to improve traffic flow, encouraging public transportation to reduce reliance on private vehicles, and installing designated pedestrian walkways to improve safety. Road widening and the installation of dedicated turning lanes are two further infrastructure upgrades that are recommended to maximise road capacity and operational effectiveness.

Zainab Ahmed Alkaissi (2024) In order to propose a knowledge-based alternative for more effective congestion detection, the project intends to use fuzzy logic to detect traffic condition states using rule-based comparisons of field traffic data. Utilising index metrics including traffic speed, speed decrease, and speed ratio in conjunction with GIS-based spatial analysis, the process creates digital maps of the levels of congestion. The study classifies urban roadways into Free-flow, Normal, Moderate, Heavy congested, and obstructed states using a Fuzzy Inference System (FIS), which tackles ambiguity and uncertainty in traffic performance assessment. Critical hotspots, such as Bab Al-Moathum zone, Al-Mawal (Mustansiriyah University), and Al-Kindi government hospital, were found by analysis of the speed decrease index. These areas had congestion index values ranging from 0.651 to 0.717, suggesting serious traffic problems. To generate a single composite congestion output that reflects various field measures and offers a more accurate assessment of traffic conditions, the model combines two input parameters. The results of 15 links that were chosen show that there are blocked regions in high-density locations, especially close to hospital and university zones, while other segments show heavy to normal levels of congestion. When compared to traditional single-parameter methods, the fuzzy inference-based methodology provides a more accurate and thorough understanding of urban street traffic overall.

Mazloh Al-Enazi (2016) intended to use a variety of GIS tools, especially network analysis and shortest path evaluation, to pinpoint areas of traffic congestion in a residential region of Jeddah, Saudi Arabia, during business hours in relation to road directions. To aid in the investigation, a geo-database was created that included the city's road system and directional characteristics. ArcGIS 10.2 was used to assess congestion hotspots according to directional flow using features like network analysis and overlay analysis.

Through the reassignment of road directions, the findings give planners important information that might help reduce traffic congestion in various areas of Jeddah city.

III. METHODOLOGY

This section presents the methodology adopted for the site survey and process of data acquisition for traffic survey and provide necessary recommendations.

IDENTIFICATION OF SITE CONDITION AND SELECTION OF STUDY

An intricate academic approach for a GIS-based assessment of traffic congestion and alternative route identification that is specific to the intersection of MP Nagar Zone I and Jyoti Talkies is provided here. Core academic concepts, current developments, and useful strategies for urban Indian situations are all covered in the technique. This thorough framework ensures coverage of literature, field data protocols, spatial analytics, route optimisation, validation, and implementation, making it suitable for thesis-level research.

Step 1- Introduction and Rationate
Step 2- Study of Research Papers
Step 3- Study Data and Data Acquisition
- **I. Location Mapping**
- **II. Data Types**
- **III. Data Collection Protocols**

Step 5- Data Collection and GIS Data base creation
- **I. Spatial Data Structure**
- **II. Attribute Data Linkage**
- **III. Data Visualization**

Step 6- GIS Based Traffic Congestion Analysis
- **I. Hotspot Identification**
- **II. Friction Point Analysis**
- **III. Temporal Variation Mapping**

Step 7- Network Analysis and Alternate Route Identification
- **I. Network Model Construction**
- **II. Least Cost Path Analysis**
- **III. Route Screening Criteria**
- **IV. Simulation of Traffic Redistribution**

Step 8- Validation and Calibration
- **I. Field Verification**
- **II. Stakeholder Feedback**
- III. Statistical Calibration

Step 9- Implementation Framework
- I. **Policy Recommendation**
- **II. Real-time Dynamic Routing**
- **III. Long Term Monitoring**

Step 10- Ethical Consideration

IV. CASE STUDY

Geographic and Demographic Profile of MP Nagar Zone I.

A well-known business and administrative district, MP Nagar Zone I is situated in the centre of Bhopal, Madhya Pradesh, India. A significant hub for the city's economy, the area is home to a wide variety of retail establishments, office buildings, government structures, and residential neighbourhoods. The region serves as a pivot point for both intra-city and regional traffic flows due to its geographic location along important arterial roads that link Bhopal's northern and southern sectors.

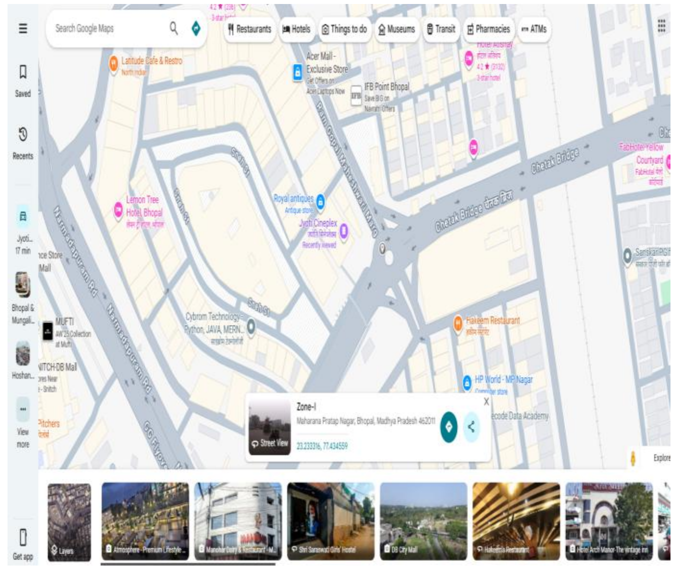

Fig 1: Jyoti Square (Map View)

Fig 2: Satellite View

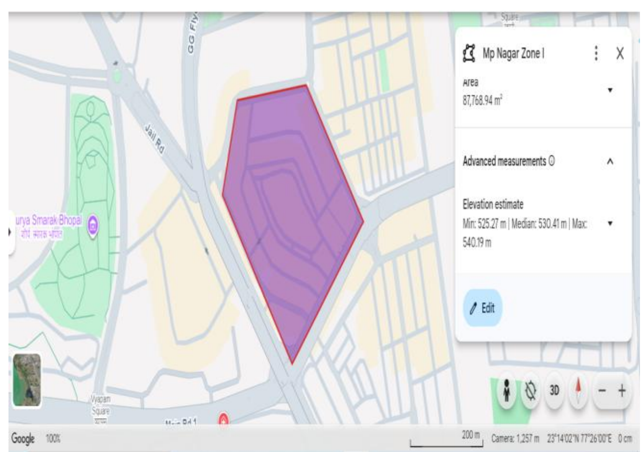

Fig 3: Map View

Fig 4: Starting Point

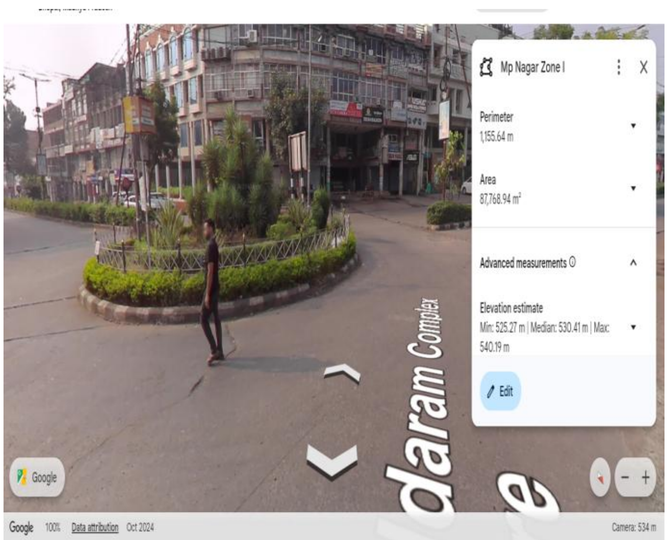

Fig 5: Ram Gopal Maheshwari Marg (Thadaram Square)

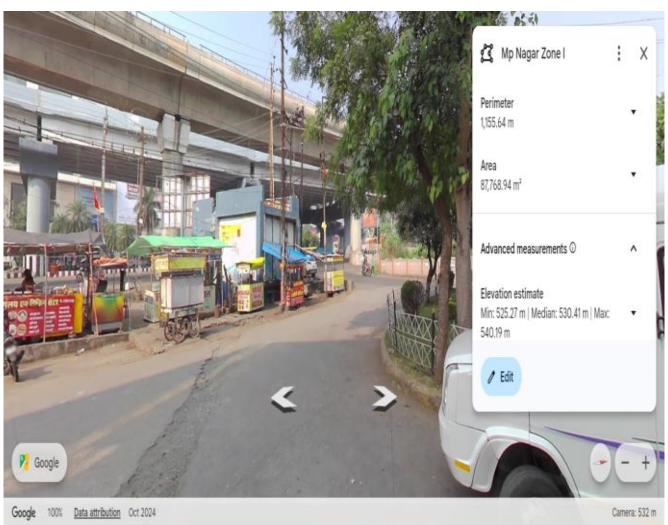

Fig 6: Jail Road Square

Fig 7: Board Office Square

V. RESULTS AND DISCUSSION

ROAD ACCIDENTS REPORTED IN BHOPAL

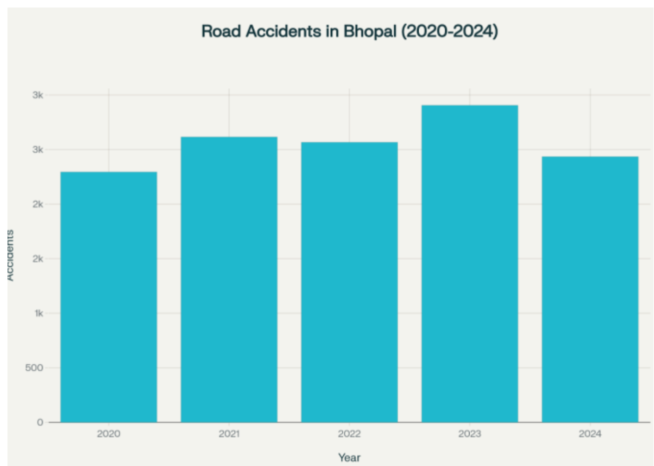

Fig 8: Reported Accidents in Bhopal (2020-2024)

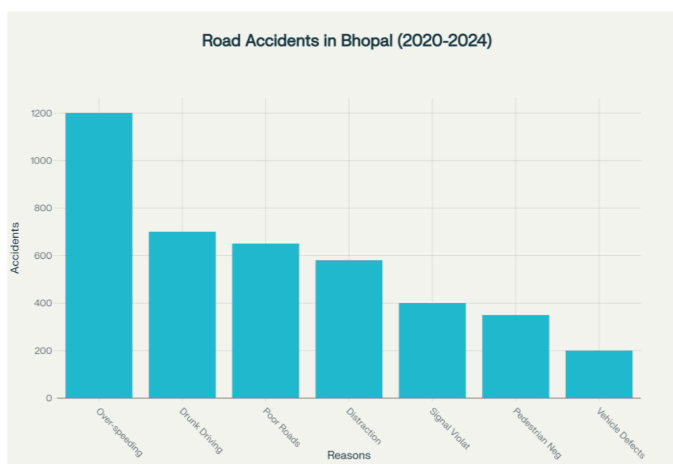

Fig 9: Reasons for Accidents reported in Bhopal

PEAK PERIOD TRAFFIC FLOW AND CONGESTION LEVELS

Using Volume to Capacity (V/C) ratios calculated from observed data and estimated roadway capacities,

Board Office Square

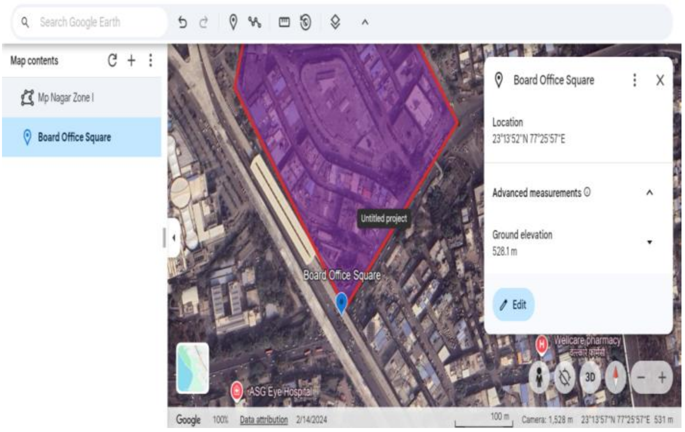

Fig 10: Board Office Square

Jyoti Talkis Square

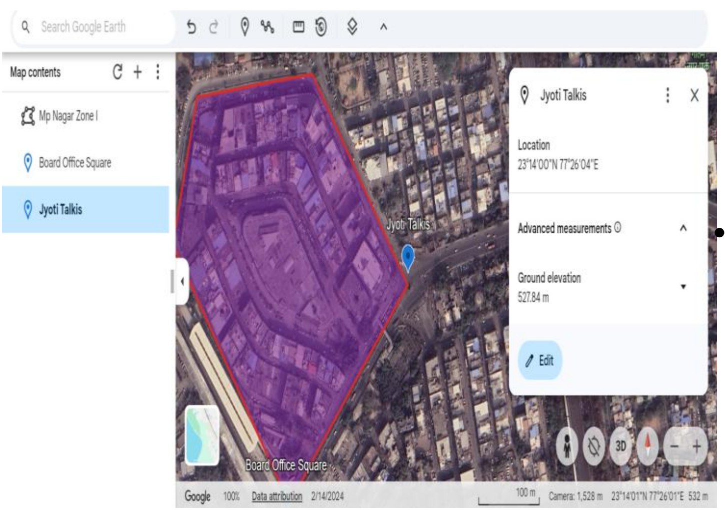

Fig 11: Jyoti Takis Square

ThadaramSquare

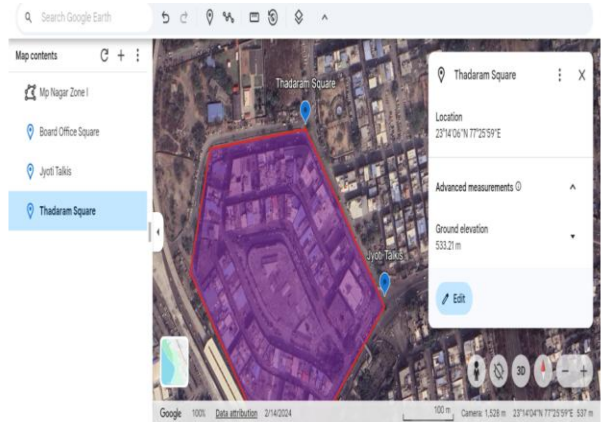

Fig 12: Thadaram Square

VI. CONCLUSION

- The temporal analysis of road accident incidence in Bhopal reveals distinct fluctuations over the period from 2020 to 2024. A comparatively lower number of accidents was recorded in 2020, followed by a noticeable increase in 2021 and a slight decline in 2022. This downward trend was interrupted in 2023, which experienced a marked peak in accident occurrences. In 2024, although a reduction in accident numbers was observed relative to the previous year, the figures remained elevated when compared to those from 2020. Such variability in accident trends highlights the dynamic nature of road safety in Bhopal, likely shaped by evolving traffic volumes, enforcement initiatives, and diverse socio-economic drivers operative throughout these years.
- Board Office Circle exhibits the highest peak hour volume at 3200 vehicles per hour (veh/hr) against an estimated capacity of 2800 veh/hr, leading to a V/C ratio of 1.14 and thus categorized as experiencing severe congestion. Jail Road, with a peak hour volume of 2800 veh/hr and a capacity of 2700 veh/hr, records a V/C ratio of 1.04, indicating high congestion. Jyoti Talkies Square presents a moderately congested situation with a V/C ratio of 0.96, derived from a volume of 2500 veh/hr relative to a 2600veh/hr capacity. Thadaram Square, at the other end of the spectrum, operates below capacity with a V/C ratio of 0.79 and is classified as having low congestion.
- Board Office Square in Bhopal is recognized as a major accident-prone location due to a convergence of infrastructural and traffic management shortcomings, including road encroachment, illegal parking, surface defects, and high vehicle flow. These risks are amplified by inadequate traffic regulation, frequent violations, and limited pedestrian facilities, leading to frequent collisions, especially involving vulnerable road users. The site is consistently ranked among Bhopal's primary blackspots, with root causes attributed to poor engineering,

ambiguous signage, and driver negligence. Recommended interventions include swift road repairs, stricter enforcement of parking laws and lane discipline, infrastructure upgrades like pedestrian overpasses and clearer signage, and adoption of Intelligent Traffic Management Systems. Coordinated efforts among municipal agencies are deemed essential for safety improvements and reducing accident rates at this critical intersection.

- Jyoti Talkies Square, located near Bhopal's commercial zones, is a critically busy and accident-prone intersection due to the confluence of high traffic volumes, inadequate road infrastructure, and inefficiencies in traffic signal management. Frequent congestion results from the junction's proximity to other major hubs, while narrow road widths and inefficient traffic light cycles exacerbate delays and risky driver behaviors. Principal accident triggers include poor lane discipline, encroachment, and pedestrian-vehicle conflicts intensified by adjacent commercial activities and ongoing construction. Recommended interventions involve signal optimization using adaptive systems, stricter lane discipline, upgraded pedestrian facilities, and expanded road approaches. Additionally, coordinated efforts among traffic authorities and urban planners, supported by public awareness campaigns and regular infrastructure maintenance, are essential for comprehensive safety enhancement at this intersection.

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